MAINE GEOLOGICAL SURVEY
Robert G. Doyle, State Geologist

GEOLOGY OF THE
MOOSE RIVER AND ROACH RIVER SYNCLINORIA
NORTHWESTERN MAINE

by

ARTHUR J. BOUCOT

with contributions

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EDWARD W. HEATH

BULLETIN No. 21

Department of Economic Development
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ABSTRACT

The Moose River and Roach River synclinoria of northwestern Maine contain the greatest thickness of fossiliferous, relatively unmetamorphosed Lower Devonian strata known in the Appalachian Mountains. Strata of Oriskany and Schoharie age, chiefly dark sandstone and slate with subordinate amounts of rhyolite, form the troughs of the synclinoria and have thicknesses up to 20,000 feet. On the flanks of the synclinoria they are unconformably underlain by erosional remnants of Helderberg, Pridoli, Ludlow, Late Llandovery, possible Silurian, Middle Ordovician, Cambrian or Ordovician, and possible Precambrian age. The strata of Silurian through Helderberg age consist chiefly of calcareous sandstone, calcareous siltstone conglomerate and arkose with a maximum thickness of about 4,000 feet. The pre-Silurian strata consist of light and dark volcanic rocks, slate, phyllite, dark sandstone, graywacke, gneiss, with unknown stratigraphic thickness, and granitic rocks. Intrusive rhyolitic rocks of Early Devonian age and intrusive granitic rocks of post-Early Devonian age are present. Possible Ordovician intrusive granitic rocks are also present. The Devonian granitic rocks are bordered by contact metamorphic aureoles.

The major structural elements associated with the Moose River and Roach River synclinoria are poorly known. The Moose River synclinorium is a northeast-southwest trending, canoe shaped structure which bifurcates on the southwest against the basement complex. Northwest of the synclinorium is the Frontenac Formation which is concluded to be conformable with the strata in the synclinorium. Between the two synclinoria is the Lobster Lake anticlinorium which contains poorly known pre-Silurian strata. Along its northwestern limit the Lobster Lake anticlinorium is bounded with angular unconformity on the northeast which relationship changes to the southwest into a high angle thrust fault. The southeastern limit of the anticlinorium has not been worked out in detail. The Roach River synclinorium is doubly plunging; being flanked to the northeast by the northwest plunging Caribou Lake anticline and to the southwest by the intrusive mass associated with Squaw Mountain.

The Moose River synclinorium has a length of over sixty miles and a maximum width of over twenty miles. The minor folds in the synclinorium are highly asymmetric, doubly plunging, and form anticlines which on the southeast side of the synclinorium have near-vertical northwest limbs and on the northwest side have near-vertical southeast limbs. The rocks of the synclinorium are cut by shear cleavage planes which form an inverted fan, those on the southeast side of the synclinorium dipping southeast and those on the northwest side dipping northwest.

An outlier of the synclinorium is situated between the two southwestern prongs in the area of basement complex. This outlier is down-faulted on its southeastern margins. The stratigraphic slip on the fault is of the order of at least several thousand feet.

The Roach River synclinorium has a length of about forty miles and a maximum width of about fifteen miles. The northeast trending Ragged Stream fault cuts the Caribou Lake anticline and terminates in the Roach River synclinorium. A maximum net slip of 14,000 feet, essentially all of which is strike slip, has been estimated from map and geometric data.

The pre-Silurian rocks of the region were folded prior to the deposition of Silurian strata indicating that the Taconic orogeny strongly affected this region. The Silurian and Devonian rocks were strongly folded and deformed during the Acadian orogeny which is probably of Middle Devonian age.

The evidence afforded by minor structures including stretched and flattened fossils, stretched pebbles, shear cleavage, rotated porphyroblasts, drag folds, boudinage, and tension fractures indicate a deformational history which included flattening of the strata normal to the fold axes in the plane of the bedding, and also elongation parallel to fold axes. It cannot be calculated from the available information whether or not the crust in this region has suffered a net shortening or a net lengthening during folding.

The igneous rocks of northwestern Maine have not been investigated in detail. Relatively young granitic rocks cut the folded rocks of the region and radiometric age determinations suggest that these igneous rocks are of Middle Devonian age. Rhyolitic and diabasic intrusive rocks are associated with the Lower Paleozoic strata and there may be several intervals of intrusive activity present. Teschenite of post-Early Devonian age has been recognized as has diorite of Early Devonian age.

All of the stratified rocks of northwestern Maine have been subjected to low-grade metamorphism with the development of metamorphic minerals characteristic of the chlorite zone in the rocks of appropriate chemical composition. Adjacent to younger intrusive rocks some of the stratified rocks have been converted into hornfels.

INTRODUCTION

Location and Area

The Moose River synclinorium (Fig. 1) of northwestern Maine is situated in northern Somerset and adjacent portions of Piscataquis and Franklin Counties. The Roach River synclinorium adjoins the northeastern portion of the Moose River synclinorium in Piscataquis County and extends southwest into Somerset County. The area involved in this report includes portions of over twelve fifteen minute quadrangles (Fig. 1).

Culture

Both synclinoria are situated in a relatively undeveloped area which serves chiefly as a source of forest products. The Town of Jackman is situated on the northwest side of the area, Eustis to the southwest, and Rockwood in the east-central part of the area. The western part of the area is traversed by U. S. Route 201. The remainder of the area during the period when the field work was in progress had a network of largely unsurfaced roads most of which were difficult for vehicles to use during wet weather.

Topography and Drainage

Northwestern Maine is a region of low, rolling hills, having an average relief of several hundred feet and a maximum relief of about 1,500 feet. Rising above these hills are a few isolated mountains with maximum relief of about 2,000 feet. The southeast slopes of these mountains tend to be precipitous, but the other slopes are relatively gentle.

The Boundary Mountains adjacent to the international boundary rise along the northwestern margin of the region between Rangeley and Jackman. This range has an average relief of over 1,000 feet and is very rugged, with many precipitous slopes. It narrows rapidly to the northeast and ends northeast of Jackman, at Boundary Bald Mountain.

The drainage pattern of the region is reticulate. In general, both major and minor streams have a northeast-southwest or a northwest-southeast alignment. The northern part of the region is drained by Moose River, which flows through Attean Pond, Wood Pond, Long Pond, and Brassua Lake before emptying into Moosehead Lake. The southern part of the area is drained by tributaries of the Kennebec River. Misery Ridge and its prolongations form the drainage divide between the Moose River and the Kennebec River. Swamps and lakes cover about 10 to 20 percent of the region.

The southeastern part of the region drains to the north, through the Spencer Lakes and Roach River into Moosehead Lake. The northeastern part of the area is drained by the West Branch of the Penobscot River through Lobster Lake, Pine Stream Flowage, Ragged Lake, and Caribou Lake, into Chesuncook Lake.

The predominant trend of linear features of the region is northeast-southwest, with a minor trend of northwest-southeast.

Geologic Controls of Topography and Drainage

The general northeast-southwest trend (Plate 13) of the topography and drainage is controlled by the fold axes and the strike of bedding and cleavage planes, which also trend northeast-southwest. The secondary northwest-southeast trend of the topography and drainage is largely controlled by a system of high-angle joints which are normal to the fold axes.

The occasional isolated mountains are underlain by igneous rocks, predominantly volcanic, and do not appear to be related to the drainage pattern; some are adjacent to large rivers, whereas others are near the headwaters of these same rivers. The mountain range paralleling the international boundary is underlain predominantly by abundant diorite-gabbro intrusives, greenstones, and massive sandstone.

The numerous lakes and swamps appear to be related to the glacial debris that blankets the region. Glacial debris forms the natural dams at the outlets of many of the lakes, although glaciated rock dams occur at the outlets of a few. Many of the swamps appear to be ponds that have become almost filled with plant debris and silt. A few quaking bogs have been found.

Southwest of the McKenney Ponds, in the Pierce Pond quadrangle, an underground stream flows through limestone of Early Devonian age. The stream, which forms the outlet for the McKenney Ponds, has hollowed out solution channels that now

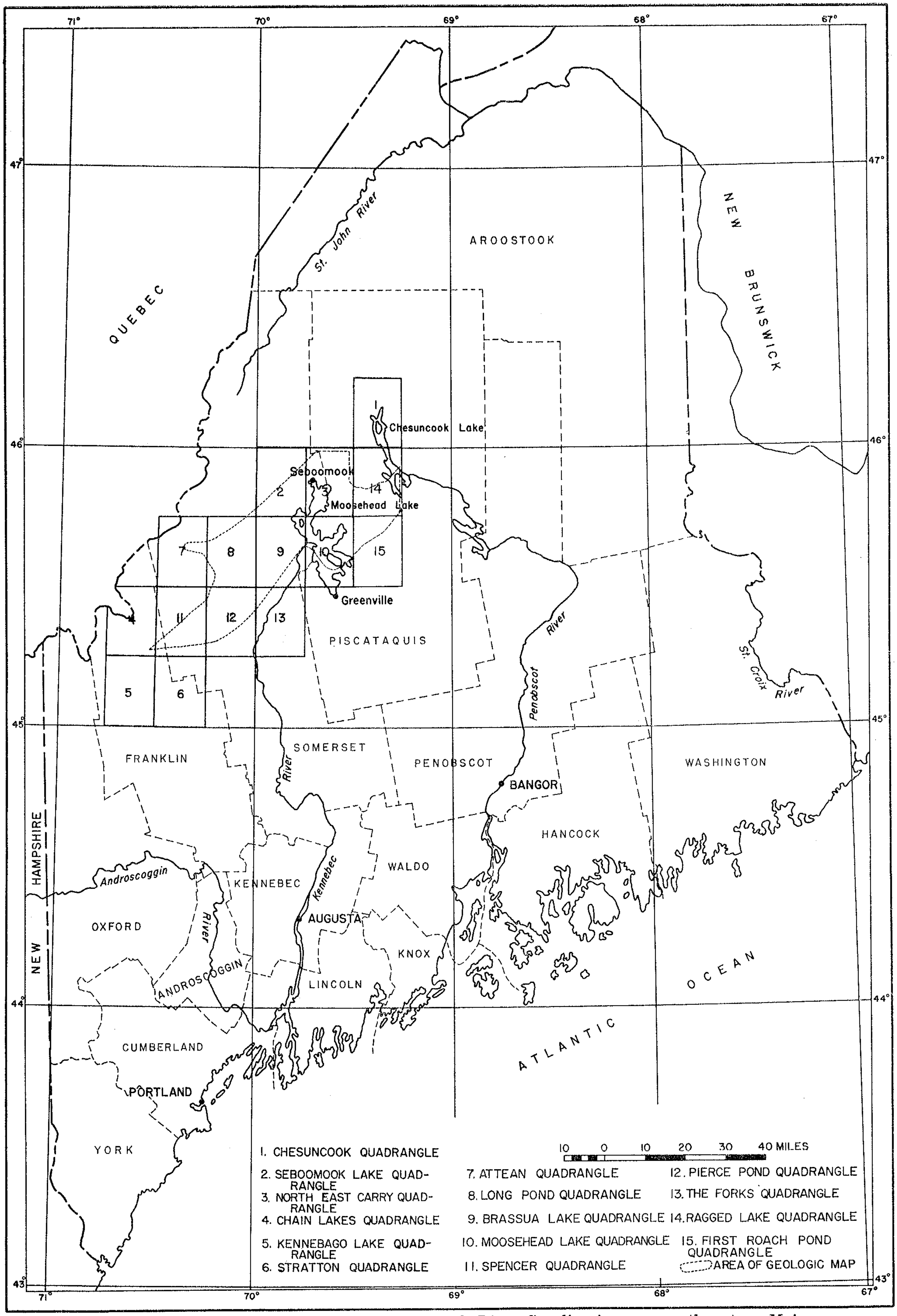

FIG. 1. Index map of the Moose River — Roach River Synclinoria area, northwestern Maine.

form small caves, (Pl. 6, fig. 1) above the present stream level. The greatest observed subsurface depth of this stream is about 20 feet.

Previous Work

Previous geologic information on the Moose River region has been of a reconnaissance nature. Charles T. Jackson (1837) first recognized Devonian rocks at Parlin Pond (Long Pond quadrangle). Charles H. Hitchcock (1861, 1862) made the first geologic maps of the region, as part of his reports on the geology of Maine. The Silurian outlier in the Spencer quadrangle was first recognized by C. H. Hitchcock and J. H. Huntington (1874). John M. Clarke (1907, 1909) first described the Early Devonian faunas of the Moose River region in some detail; he also presented geologic sketch maps based on observations of Olof Nylander, who had collected the fossils that Clarke described. George Otis Smith (in Barrows, 1907, p. 4) first recognized the presence of volcanic rocks; mentioning that Mount Kineo is a porphyritic rhyolite. Pirsson and Schuchert (1914) described an occurrence of Early Devonian fossils in the Parlin Stream area and also an occurrence of diabase.

Descriptions of many invertebrates from the Moose River region are included in a paper on the Chapman Sandstone fauna by H. S. Williams and C. L. Breger (1916). E. H. Perkins (1925) presented the results of reconnaissance over the central portion of the region. E. S. C. Smith (1925, 1930, 1933) found that rhyolitic rocks form the prominent hills in the southeastern part of the region and he provides the first adequate description of these rhyolites, together with chemical analyses. Toppan (1932) summarized the previous geologic work in northern Maine and also contributed a number of miscellaneous observations, particularly in the area of Ripogenus Dam. Keith's geologic map of Maine (1933), which included the Moose River region, is now out of date.

Goldring (1933, p. 153-165) described *Rhodacrinus nortoni* from a glacial boulder found at Caratunk, Maine. This boulder was undoubtedly derived from the Tarratine Formation to the north as shown by citation of *Leptocoelia flabellites* (this form is present to the north only in Tarratine age rocks) and E. S. C. Smith's assignment of the rock to the "Moose River sandstone." Hurley and Thompson (1950) published the first relatively large-scale geologic map which outlines the boundaries of the Moose River synclinorium and indicates something of the stratigraphy and structure of its rocks. Woodard (1950) mapped and described a portion of the Spencer quadrangle, including part of the Silurian outlier.

Boucot (1953) and Boucot, Brace and Demar (1958) have studied the characteristics of shell beds within the Tarratine Formation. Boucot, Harper, and Rhea (1959) described the geology of the Beck Pond area in detail; Boucot, Griffin, Denton, and Perry (1959) described the geology of the Spencer Stream area in detail.

Pankiwskyj (1959) wrote an unpublished B.S. thesis on the Limestone Hill area and Heath (1959) wrote an unpublished M.S. thesis on the Roach River Synclinorium; both theses being done under Boucot's direction while at the Massachusetts Institute of Technology. Boucot (1959, p. 16-24) has described *Metaplasia* cf. *M. paucicostata* from the McKenney Ponds Limestone Member, *Metaplasia minuta* from the main part of the Tomhegan Formation, and *Plicoplasia plicata* from the main part of the Tarratine Formation. Oliver (1960) described Devonian rugose corals from the area. Boucot (1961) summarized the stratigraphy of the Moose River synclinorium. Stumm (1962) described Silurian corals from the area. Boucot (1963) described and defined the globithyrinid facies. Boucot, *et al.* (1963) described a new species of *Mutationella* from the area; Boucot and Amsden (1964) described *Chonostrophiella* from the area; Boucot, Griscom, and Allingham (1964) presented a summary of the geology of northern Maine which includes this region. Boucot, Field, Fletcher, Forbes, Naylor, and Pavlides (1964) cited material regarding Helderberg age beds, teschenites, and information bearing on the Acadian orogeny from Somerset County. Albee and Boudette (1965) have provided a geological map of the Attean quadrangle which will supersede the work done in this area by Boucot (those portions of the Attean quadrangle mapped earlier by Boucot have been modified in the light of Albee and Boudette's work).

Boucot and Yochelson (1966) described gastropods from the area, and Boucot, Harper, and Rhea (1966) supplemented their earlier study of the Beck Pond area with additional laboratory data.

Purpose and Scope of Investigation

Although fossiliferous Devonian rocks were first reported from the Moose River region of northwestern Maine more than 120 years ago, no systematic investigation of them has previously been made. The present investigation of that area was begun in 1948 at the suggestion of Dr. Preston E. Cloud, Jr., while Boucot was a student in the Department of Geology, Harvard University.

The initial purpose of the investigation was to determine the Early Devonian stratigraphy and to study the paleontology of the associated invertebrate fossils. Preliminary field work, however, showed that understanding of the complex structure of the region was necessary for understanding of the stratigraphy. The scope of the investigation was then enlarged to include geologic mapping of the areas underlain by Lower Devonian rocks, such mapping to be only as detailed as required for working out

the stratigraphy. The major structural feature of the area was found to be a synclinorium within which the Devonian strata lie. As field work continued, mapping was extend to the surrounding areas of pre-Devonian rocks in order to determine their relationships with the Devonian rocks in the synclinorium. The mineralogy and petrography of the sedimentary and volcanic rocks of the region were considered to be outside the scope of the investigation.

Field work was started in the summer of 1948 and was continued through the summer of 1954. The area (Fig.1) studied extends across Franklin, Somerset, and Piscataquis Counties in a strip about 60 miles long by about 15 to 25 miles wide, and includes all or parts of the following quadrangles: Chesuncook, Seboomook Lake, North East Carry, Chain Lakes, Attean, Long Pond, Brassua Lake, Moosehead Lake, Spencer, Pierce Pond, The Forks, Ragged Lake, and First Roach Pond.

Financial support for the 1948 field season was provided by Harvard University. From 1949 through 1956 the investigation was under the auspices of the U. S. Geological Survey.

Paleontologic studies of the invertebrate fauna dealt primarily with the brachiopods, the most abundant fossils in the region. The brachiopods and the gastropods were Boucot's responsibility; the remaining faunal groups were assigned to other paleontologists.

A preliminary report based on the first four seasons of field work was submitted to Harvard University in partial fulfillment of the requirements for the doctoral degree. Subsequent field work has, of course, modified the conclusions of that report.

Heath's field work in the Roach River synclinorium was done during fourteen weeks of the summer of 1958 and his laboratory studies during the following winter. Heath's work was done while a student in the Department of Geology and Geophysics, Massachusetts Institute of Technology, as partial fulfillment of the requirements for a Masters degree. The work was under Boucot's supervision and was a natural extension of his own earlier studies in the region.

Field Methods

For the southern part of the region (below latitude 45° 45′) the geologic map of the area was compiled on the topographic base maps (1:62,500) of the U. S. Geological Survey. For the northern part of the region (above latitude 45° 45′) no topographic maps were available and mapping was done on maps compiled from uncontrolled aerial photographs and woods maps of the lumber companies that operate in that area. After completion of the field work, Survey topographic maps for this northern area became available, and the geologic data that had been collected was transferred to them. In places some of these topographic maps, in particular, that of the Spencer quadrangle, were found to be unreliable in detail.

In small areas where the structure was very complex or where outcrops were very abundant, pace and compass or tape and compass maps were made to supplement the regular topographic maps.

The entire region is densely wooded, with few landmarks that can be used for resection. Consequently, it was necessary to maintain continuous pace and compass traverses during work in the woods.

The general order of field work was as follows: (1) the roads in the region, (2) the lakeshores, (3) the streams and rivers, and (4) the tops of the ridges. In most places the slopes of the hills, particularly the lower slopes, are covered by a veneer of glacial drift that conceals the bedrock. The information collected on stream traverses was plotted on the base maps by means of aneroid elevations combined with pace count. Lake shore information was plotted directly on the base maps.

Most of the fault contacts and formational contacts are covered by glacial debris. In some critical places these contacts were uncovered with pick and shovel.

Aerial photographs were not employed during the work. Contacts were walked out in cases where their precise location was critical to an understanding of the stratigraphy. Several hundred thin sections of the sedimentary and volcanic rocks were studied petrographically, and a large number of polished and sawn slabs were examined both megascopically and microscopically.

Nature and Location of Bedrock Exposures

Bedrock exposures form not more than ten percent of the area of northwestern Maine and, therefore, it becomes exceedingly important for the geologist to establish the location and concentration of outcrop. Outcrops are rare along roads and trails, which are built parallel to stream valleys developed on thick glacial debris. Those outcrops which do occur in the roadbeds consist of bedrock knobs and pavements barely scraped clean by the bulldozer work.

Lakeshores are the next most accessible area, where intermittent outcrops, both as cliffs and polished pavements are exposed; the latter are generally almost flush with the lake surface. The flush character of many of the outcrops makes it mandatory that the shores be traversed either on foot or by a shorehugging boat in which the geologist is able to stand up to view the shore.

Stream traverses are essential in this region, but here again, it is difficult to predict the exact location of possible outcrop. The thick undergrowth along the banks requires that the stream bed be walked.

Many streams have incised through the glacial mantle and provide excellent bedrock localities.

Swamps are unlikely places to look for outcrops, but unfortunately they usually occur in critical mapping areas where geologic information is essential. It was found that exposures occur along the margins of some swamps, possibly because the swamps were formerly ponds along whose margins icepush had removed the thin veneer of glacial debris to expose the bedrock. Outcrops are rarely found in the middle of swamps, but again, the situation of most swamps makes such rare outcrops of great value.

The crests of most ridges are usually formed by bedrock. Many of the ridges have been burned over and thick vegetation has never been re-established to cover the bedrock with a layer of humus and plant debris. The burned over ridges are readily apparent by their bald appearance which contrasts sharply with that of wooded neighbors. The wooded ridges are very difficult to traverse because of the thick "blackgrowth" which occurs in this location.

The lower two-thirds of the hillsides are almost entirely devoid of bedrock exposures because of the thin veneer of glacial debris.

Acknowledgments

Dr. Preston E. Cloud, Jr., suggested the problem to Boucot, spent about three weeks in the field with him and encouraged the project in every way possible. Without his help and interest the project could not have been accomplished.

Dr. G. Arthur Cooper informally guided Boucot in the study of the brachiopods during the period July 1951 to June 1956. Without his aid and interest the stratigraphic paleontology would have been far less useful. It is difficult to express in words our indebtedness for the many hours spent in discussion and consultation with Dr. Cooper.

Professor Marland P. Billings spent one week in the field with Boucot, gave much help in solving the structural problems encountered, and spent long hours editing the preliminary report which was submitted to Harvard University. Professor Billings' wide grasp of the problems of Appalachian geology were of great help and guidance to the writer through numerous discussions.

Professor James B. Thompson, Jr. spent several days in the field with Boucot and, through his wide knowledge of the geology and literature of this region, contributed greatly to the regional interpretations and correlations with other portions of the northern Appalachians.

The field work was greatly facilitated by the following field assistants: Mrs. Barbara P. Boucot, from 1948 to 1954, Mr. John W. Mathews in 1948, Mr. Janos Szatai in 1949, Mr. Paul deVergie and Mr. William B. Joyner in 1950, Mr. Arthur Watt from 1951 to 1953, Mr. Rudolph Kopf in 1953, Mr. David Rosenbaum in 1953, and Mr. Peter Clark in 1958.

Mr. Robert G. Schmidt accompanied Professor Harry B. Whittington during a short stay in the region, and contributed to the understanding of the volcanic rocks.

Thanks are due the following for their advice and counsel: the late Professor Percy Raymond of Harvard University, Professor E. S. C. Smith, formerly of Union College, Professor Joseph Trefethen, former State Geologist of Maine, Dr. Robert B. Neuman, Dr. J. Thomas Dutro, and Dr. Charles Milton of the U. S. Geological Survey.

Dr. C. W Wolfe, Boston University, brought the occurrence of fossiliferous rocks on Limestone Hill to Boucot's attention and kindly submitted his collections for study.

Thanks are due to Mrs. Barbara Boucot who did the preliminary geological drafting of the maps, charts, and diagrams, and compiled the appendix dealing with the fossil localities of the Moose River synclinorium.

Field assistants during the summers of 1949 and 1950 were supported by grants from the Department of Geology, Harvard University.

Both the Hollingsworth and Whitney Paper Company, Waterville, Maine, and the Great Northern Paper Company, Bangor, Maine, greatly facilitated the work by the loan of aerial photographs and by putting many of their facilities at our disposal.

Dr. William F. Brace spent one day in the field with Heath, helping significantly with several structural problems.

Thanks are also due to Dr. Arden Albee for a careful review of the manuscript; to Dr. Jean M. Berdan, U. S. Geological Survey for identification of the ostracodes and review of the sections of the manuscript dealing with ostracodes; and to Dr. William A. Oliver, Jr., U. S. Geological Survey, for identification of the corals where not otherwise specified. Dr. Gilbert Klapper, Pan American Petroleum Corp., Tulsa, kindly identified the conodonts.

We are grateful to Spooner Mines and Oils, Ltd., 80 Richmond Street, West Toronto, Ontario, for permission to use information obtained from a borehole in the Pierce Pond quadrangle, and for outcrop data from Bean Brook Mountain.

STRATIGRAPHY

General Stratigraphic Relationships

The Moose River and Roach River synclinoria contain the greatest stratigraphic thickness of Lower Devonian strata (Figs. 2, 3, 4, 6) known in the Appalachian Mountain belt. These strata, the young-

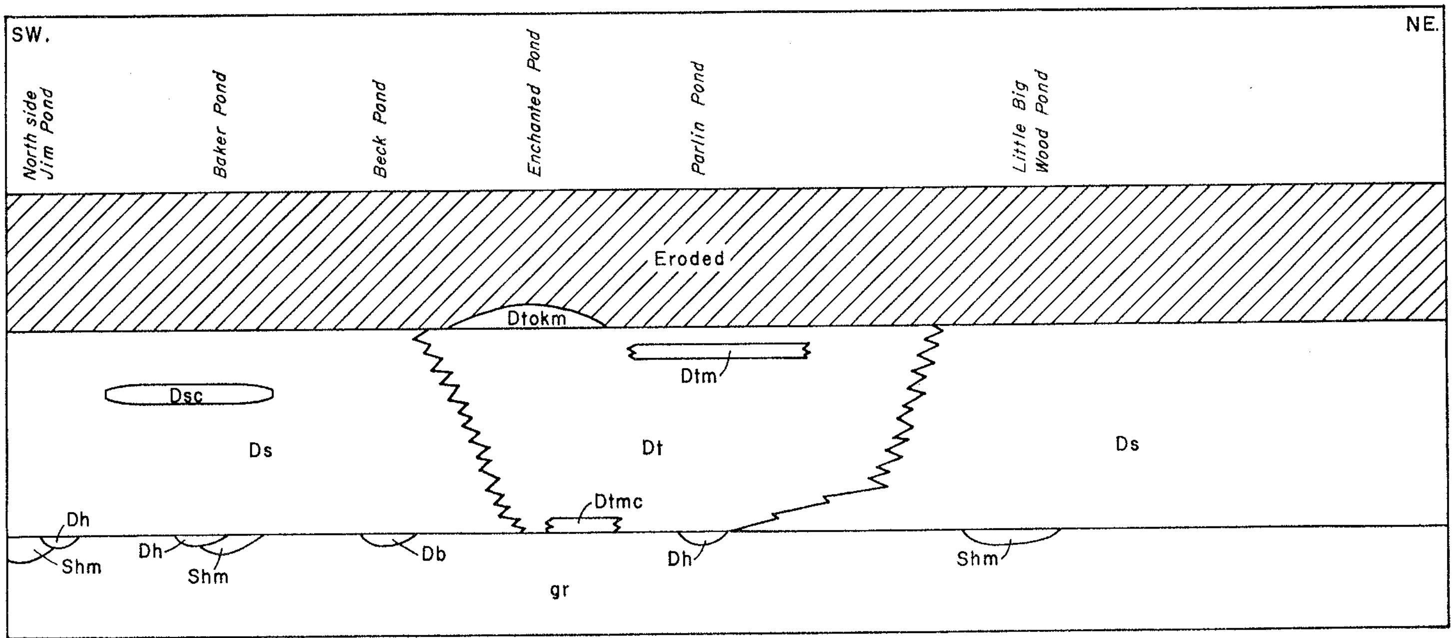

FIG. 2. Inferred stratigraphic relations of the Silurian and Devonian strata on the northwest flank of the Moose River synclinorium.

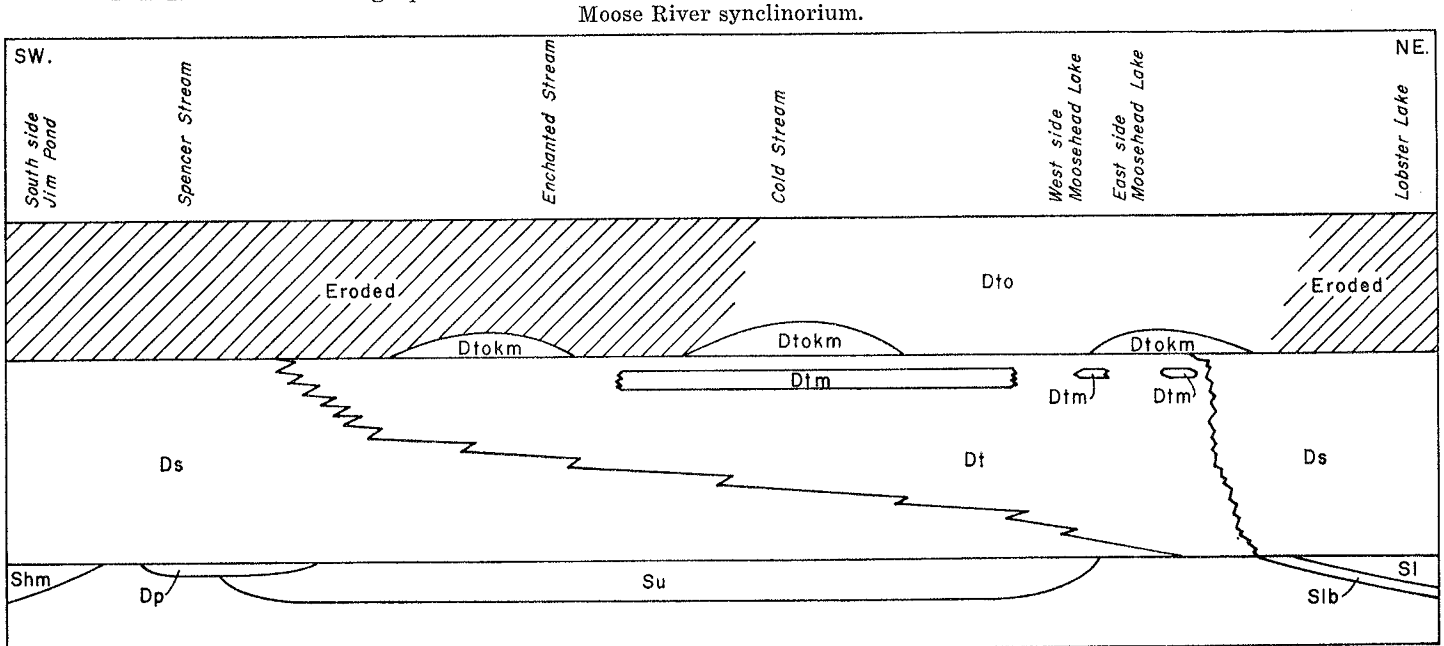

FIG. 3. Inferred stratigraphic relations of the Silurian and Devonian strata on the southeast flank of the Moose River synclinorium.

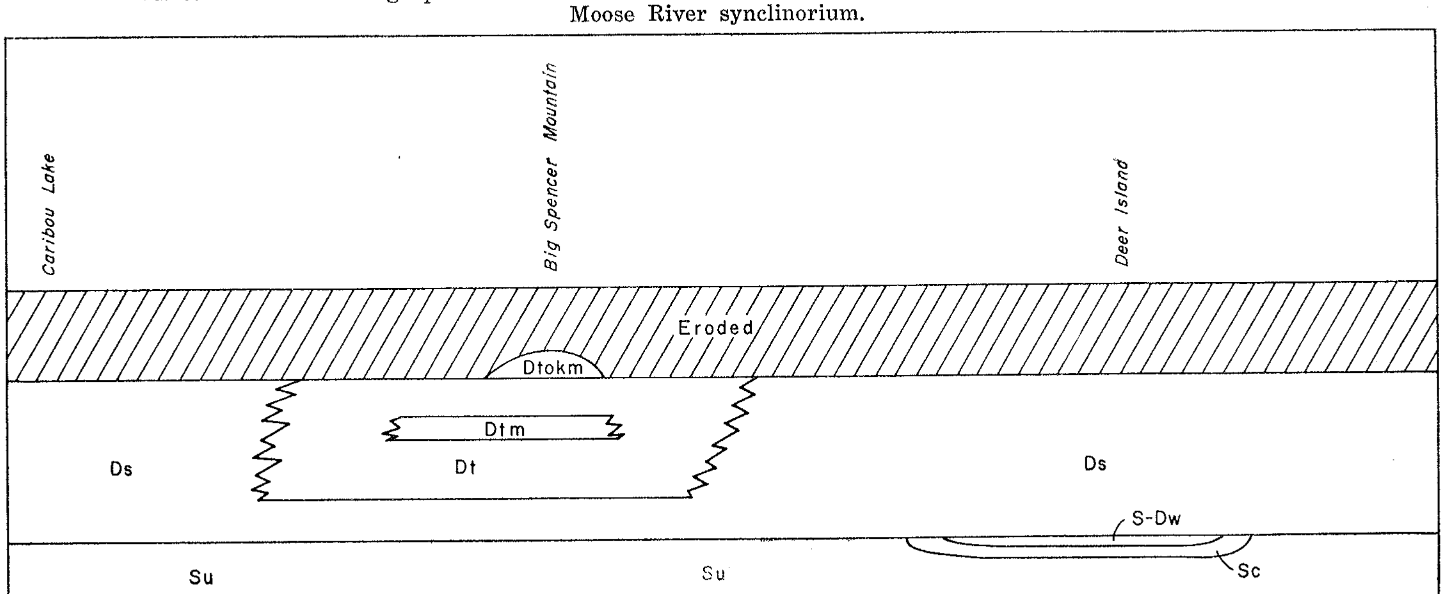

FIG. 4. Inferred stratigraphic relations of the Silurian and Devonian strata in the Roach River synclinorium.

est in the region, are almost entirely of Oriskany and Schoharie age. The strata of Schoharie age are found in the Tomhegan Formation. The strata of Oriskany age are found in the Tarratine Formation, and the Seboomook Formation.

The Tomhegan Formation, the youngest unit, consists of a main part and a basal member, the Kineo Volcanic Member. The main part, predominantly dark sandstone and rusty-weathering dark siltstone, contains fossils of Schoharie age; but the Kineo Volcanic Member cannot be well dated by means of fossils. The Schoharie age strata of the Tomhegan Formation are distinguished from the Oriskany age strata below either by the intervening rocks of the Kineo Volcanic Member or by an abundance of volcanic debris in the base of the main part of the Tomhegan.

Beneath the strata of Schoharie age and the intervening volcanics is an intergrading sedimentary complex containing fossils of Oriskany age. This complex, the Tarratine Formation, contains a main part of medium-grained, dark sandstone, siltstone, and slate; a quartzite member, the Misery Quartzite, in the upper third; and a limestone member of very restricted extent, The McKenney Ponds Limestone Member, at the base. The Tarratine Formation and the overlying Tomhegan Formation together with the Heald Mountain Rhyolite make up the Moose River Group.

The Tarratine Formation grades laterally into the distinctive cyclically-layered slate and dark sandstone of the Seboomook Formation, which contains fossils of Oriskany age. The Seboomook Formation also occurs in southeastern Moosehead Lake above the Whisky Quartzite. To the southwest and southeast the Tarratine grades into the Seboomook Formation, which here includes a Camera Hill Greenstone Member.

The formations underlying the strata of Schoharie and Oriskany age are discontinuous areally, with unconformities between many of the units. They occur in scattered areas around the edges of the synclinoria (Fig. 2). Some of these rocks are well dated by fossils; others can be dated and correlated only by their stratigraphic position relative to well-dated units or by their lithologic similarity to well-dated units. Most of these formations are of Silurian age, but several are of Early Devonian age.

In the Spencer Lake area (Figs. 2, 6), a very restricted unit of Early Devonian (Helderberg) age, the Beck Pond Limestone, rests unconformably upon the basement complex and is overlain by strata of Helderberg and Oriskany age.

Also in the Spencer Lake area is a unit of interbedded felsite and limestone. This unit, the Parker Bog Formation, (Figs. 3, 6) contains fossils of Early Devonian (Helderberg) age. Rocks of Parker Bog lithology are unknown elsewhere in northern Maine.

An additional Helderberg age unit in the Spencer Lake area (Figs. 2, 6) is the Hobbstown Formation which consists of roundstone conglomerate, breccia, and arkose distributed in a very patchy and irregular manner. The Hobbstown rests unconformably on the basement complex and the Hardwood Mountain Formation. The base of the Hobbstown Formation contains fossils of Ludlow-Pridoli age at several localities (interpreted as having been reworked from the underlying Hardwood Mountain Formation) and of Devonian age at two localities.

The Whisky Quartzite found in the southeastern Moosehead Lake area and the Frontenac Formation on the northwest side of the Moose River synclinorium are of possible Early Devonian age (Figs. 2, 6). The Capens Formation is a thin unit of interbedded red and green slate of probable Silurian age known only from the southeastern Moosehead Lake area. Neither the Capens Formation nor the Whisky Quartzite have yielded fossils.

Paralleling the southeast margin of the Moose River synclinorium from southeastern Moosehead Lake to Spencer Stream are relatively unfossiliferous slates and shaly limestones termed 'Undifferentiated Strata of Silurian Age'.

Rocks of proved Late Silurian age occur at both the northeast and southwest ends of the Moose River synclinorium. Those at the southwest end are assigned to the Hardwood Mountain Formation and those at the northeast end to the Lobster Lake Formation (Figs. 2, 3, 6). The Lobster Lake Formation consists of a basal red bed unit, the Big Claw Member, and a main unit composed largely of siltstone, calcareous sandstone, calcareous slate, and limestone conglomerate. The Hardwood Mountain Formation contains rock types similar to those in the main part of the Lobster Lake Formation.

On the northeast and southeast sides of the Roach River synclinorium are fossiliferous undifferentiated strata of Silurian age (Fig. 4). They consist chiefly of calcareous siltstone and impure limestone together with minor amounts of quartzite, basal conglomerate, and red and green slate. Fossils of Late Llandovery, Late Wenlock, and Ludlow age have been recovered from this unit.

Rocks containing Lower Silurian fossils have not been recognized in the Moose River synclinorium, but Late Llandovery age fossils have been found at two isolated localities of fossiliferous lime-silicate hornfels southeast of the synclinorium. The stratigraphic relations of these Lower Silurian rocks to those of Ludlow age within the synclinorium are unknown.

The youngest pre-Silurian rocks are the Lobster Mountain Volcanics (Figs. 5, 6) that crop out in both the southwest and northeast portions of the Moose River synclinorium. The volcanic rocks are inferred to be of Middle or Upper Ordovician age, but the paleontologic evidence is meager.

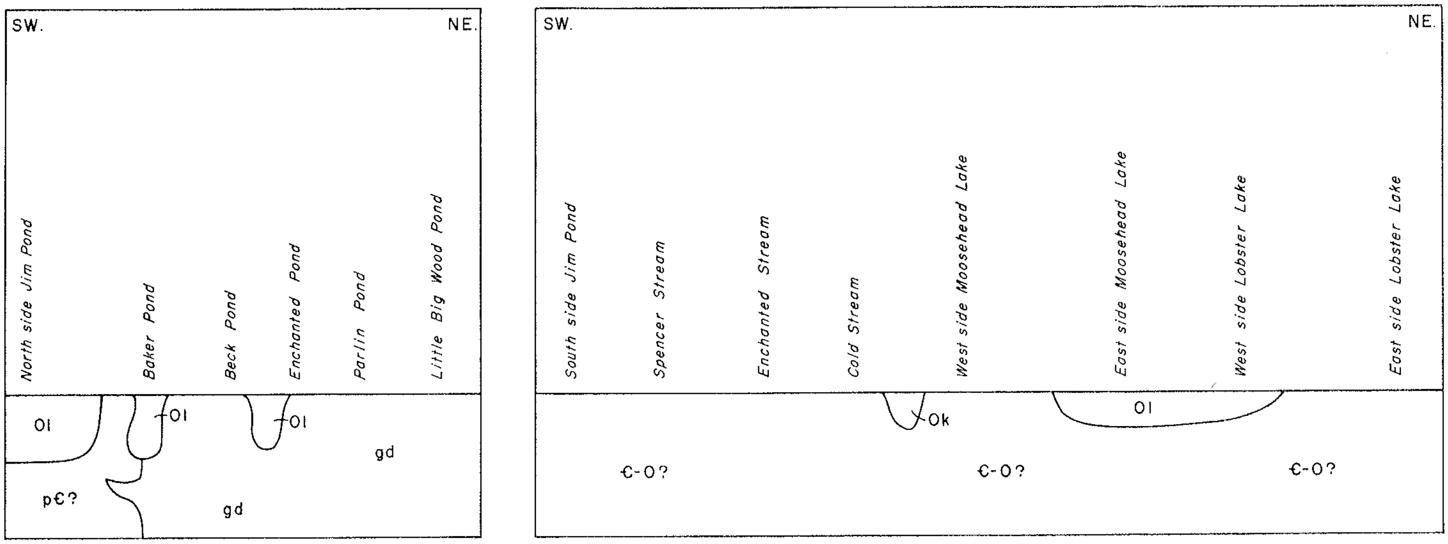

FIG. 5. Inferred stratigraphic relations of pre-Silurian strata in the region.

A profound unconformity separates the pre-Silurian rocks from the post-Ordovician rocks.

The oldest rocks of proved Paleozoic age are volcanic rocks on the southeast border of the Moose River synclinorium (Figs. 5, 6). These are assigned to the Kennebec Formation, of Middle Ordovician age. Associated with the Kennebec Formation are a variety of sedimentary and volcanic rocks, chiefly slate, phyllite, graywacke, and subgraywacke which have been designated as Cambrian or Ordovician rocks.

Granitic and gneissic basement complex (Figs. 5, 6) of possible Ordovician and Precambrian ages are inferred to be the oldest rock units in the region.

The fossil localities cited in the *manuscript* as four digit localities preceded by SD- or not preceded by an SD- are from the U. S. Geological Survey Silurian-Devonian locality catalogue.

ROCKS OF LOWER DEVONIAN AGE

Moose River Group

The term Moose River Group is used as defined by Boucot (1961, p. 160-161). It includes an upper Tomhegan Formation of Schoharie age and a lower Tarratine Formation of Oriskany age (Figs. 2, 3, 4, 6). Also included now is the Heald Mountain Rhyolite.

TOMHEGAN FORMATION
(pl. 11, fig. 1)

The term "Tomhegan Formation" is used here as defined by Boucot (1961, p. 160) with the addition to it of the rhyolitic rocks exposed on Big Spencer Mountain in the core of the Roach River synclinorium. The Formation has two subdivisions: an upper unit, the main part of the Formation; and a lower unit, the Kineo Volcanic Member.

MAIN PART OF THE TOMHEGAN FORMATION

Distribution

The strata of the main part of the Tomhegan Formation are restricted to the core of the Moose River synclinorium. The most northeasterly exposures are located at Norcross Point on Moosehead Lake, and the most southwesterly in the area between Johnson Mountain and Coburn Mountain southwest of Jackman. The main part covers an area of low elevation that is dissected into irregular hills with relief ranging from 50 to several hundred feet.

Thickness

In the Moose River region the top of the main part of the Tomhegan Formation has been eroded away. The maximum thickness still preserved is estimated from cross sections to be about 6,000 feet.

Description

The rocks of the main part include dark sandstone, dark tuffaceous sandstone, slate, rusty-weathering siltstone, and quartzite. Sandstone, tuffaceous sandstone, and slate are most abundant to the northwest; siltstone and slate, to the southeast. Quartzite is present in minor amount.

Sandstone

The dark sandstone and dark tuffaceous sandstone form lenticular exposures of massively-bedded layers that vary from a few feet to 10 feet in thickness. The exposures are commonly cut by northwest-trending joints with steep dips. These sandstones are blue-gray on fresh surfaces and gray on weathered surfaces. They consist of fine to medium sand-sized quartz, feldspar, and felsite grains imbedded in a fine-grained, dark matrix.

The tuffaceous sandstone may have up to 70 percent felsite and is non-quartzitic. Where weathered, the more highly felsitic rocks exhibit a thin chalky-

AGE		LOBSTER LAKE	WEST SIDE OF MOOSEHEAD LAKE	DEER IS. AREA MOOSEHEAD LAKE	SPENCER STREAM	JIM POND	BECK POND	ENCHANTED POND	LITTLE BIG WOOD POND	BIG SPENCER MOUNTAIN AREA N.W.	BIG SPENCER MOUNTAIN AREA S.E.
DEVONIAN	LOWER SCHOHARIE		Tomhegan Formation					Tomhegan Formation		Tomhegan Formation	
	ORISKANY	Seboomook Formation	Tarratine Formation	Seboomook Formation	Seboomook Formation	Seboomook Formation	Seboomook Formation	Tarratine Fm. / Seboomook Formation	Seboomook Formation	Tarratine Fm. / Seboomook Formation	
	UPPER HELDERBERG			Whisky Quartzite	Parker Bog Formation	Hobbstown Formation	Beck Pond Limestone				
	LOWER HELDERBERG										
SILURIAN	PRIDOLI					Hardwood Mountain Formation			Hardwood Mountain Formation		
	LUDLOW	Lobster Lake Formation	Undifferentiated Strata	Capens Formation	Undifferentiated Strata					Lobster Lake Formation	Undifferentiated Strata
	WENLOCK			Undifferentiated Strata							
	LLANDOVERY										
ORDOVICIAN		Lobster Mt. Volcanics	Kennebec Formation			Lobster Mt. Volcanics		Lobster Mt. Volcanics		1	
CAMBRIAN		Sedimentary & Volcanic Rocks, undifferentiated	Sedimentary & Volcanic Rocks, undifferentiated	Sedimentary & Volcanic Rocks, undifferentiated	Sedimentary & Volcanic Rocks, undifferentiated	Sedimentary & Volcanic Rocks, undifferentiated				Sedimentary & Volcanic Rocks, undifferentiated	
PRECAMBRIAN						Gneissic Basement Complex					

1. Lobster Mountain Volcanics

FIG. 6. Correlation table of Paleozoic strata in the Moose River and Roach River synclinoria.

white rind formed from the altered feldspathic materials. Some of the tuffaceous sandstone contains small pebbles with thin laminae of comminuted plant material.

The non-tuffaceous sandstone is in general quartzitic, more massive, and more thickly bedded than the tuffaceous sandstone. Its color is darker, its grain is finer, and it strongly resembles the sandstone of the Tarratine Formation.

Slate

The slate of the main part is cut by closely-spaced cleavage planes and by joints at right angles to the cleavage planes. It is blue-gray on fresh surfaces and gray on weathered surfaces, and is very similar to the slate in the Tarratine Formation. The following analysis of slate from the main part of the Tomhegan was made:

Analysis of rusty-weathering, sandy, blue-gray slate from railroad cut ¼ mi. E. of Tarratine, Brassua Lake quadrangle, Somerset County, Maine, (see Pl. 15). Report No. IDC-13 (Lab. No. ID-21050) (Harry M. Hyman, analyst; carbon determination by Charlotte Warshaw).

	Percent
SiO_2	70.36
Al_2O_3	13.07
Fe_2O_3	0.42
FeO	4.58
MgO	2.11
CaO	0.57
Na_2O	1.71
K_2O	2.26
H_2O-	0.10
H_2O+	2.90
TiO_2	0.81
CO_2	0.46
P_2O_5	0.16
S	0.02
MnO	0.06
C	0.37
Total	99.96
Less O for S	0.01
Final total	99.95

Siltstone

Exposures of the rusty-weathering siltstone are cut up into flattish ellipsoids by cleavage planes at an angle to the bedding which tends to obscure the bedding. Gray slate and white-weathering quartzite bands are interlayered with the siltstone which is characterized by beds ranging from fractions of an inch to several feet in thickness. The rusty weathering results from oxidation of pyrite, which is visible on flat, fresh surfaces of the rock. Most of this pyrite occurs as small, scattered anhedral grains, but in some places nodules up to several inches in diameter have been observed. The siltstone contains about 20 to 50 percent angular, fine to medium sand-sized quartz grains and possibly 5 percent feldspar grains in a fine-grained, dark matrix. The rock is blue-gray on fresh surfaces.

This siltstone contains a meager fauna characterized by abundant specimens of the brachiopod *Globithyris*. The fauna commonly has the character of a life assemblage (Boucot, 1953, p. 25-40).

Quartzite

The quartzite, making up less than 5 percent of the total volume of the member, consists of fine to medium sand-sized, angular grains. At most localities, the quartzite beds are less than 10 feet thick. Some of the quartzite layers also contain globithyrids, but their valves are disarticulated and the fauna has the character of a death assemblage.

Contacts

The upper contact of the main part of the Tomhegan Formation in the Moose River synclinorium has been removed by erosion. The lower contact in some places is with the Kineo Volcanic Member and in other places with the Tarratine Formation.

The contact with the Kineo Volcanic Member is exposed at two localities. On Eagle Mountain the main part of the Tomhegan is in contact with a massive felsite body of the Kineo. Here the contact consists of poorly rounded cobbles and boulders of massive felsite in a matrix of gray siltstone. The cobbles and boulders of this conglomerate are derived from the underlying felsite of Eagle Mountain, and the siltstone is similar to that in the overlying main part.

On the southwest shore of Brassua Lake the main part is in contact with a small flow of massive felsite of the Kineo. The contact exhibits cobbles of spherulitic felsite in a matrix of gray siltstone. The top of the flow grades up into the siltstone with fewer cobbles present higher in the section. The cobbles are derived from the underlying flow.

Elsewhere in the synclinorium the actual contact has not been seen. Many of the volcanic conglomerate and tuff beds are overlain by sedimentary rocks that may belong to the main part of the Tomhegan, but ignorance of the precise location of the highest beds containing abundant coarse volcanic material prevents certainty. In any event, the field relationships between the tuffs and conglomerates of the Kineo with the overlying main part suggest that a gradational relationship exists.

Where the Tomhegan Formation is in contact with the underlying Tarratine Formation, bedding attitudes on both sides of the contact indicate that it is conformable. A faunal break below the fauna characterized by *Amphigenia* and *Dalejina* suggests that the Tarratine and Tomhegan Formations are

separated by a disconformity. This break occupies the position of the *Etymothyris* zone with the *Amphigenia* zone above and the *Rensselaeria* zone below. On the northwest side of the Moose River synclinorium, where the Kineo is almost completely absent, the abundant tuffaceous sandstones of the Tomhegan are easily distinguished from the thinly bedded in-interlayered slate and dark sandstone of the underlying Tarratine Formation, and this lithologic distinction is supported by a number of fossil occurrences. On the southeast side of the synclinorium, in those areas where the volcanic rocks of the Kineo are absent, it is not possible to make a distinction between the rusty-weathering *Globithyris* bearing siltstone of the Tomhegan and a lithologically similar siltstone that occurs in a few places in the top of the Tarratine, but where dark sandstone of the Tarratine Formation is present, the distinction is easily made.

Facies Relations

Although subdivision of the main part of the Tomhegan Formation has not proved practicable, it is very noticeable that the beds on the northwest side of the synclinorium are predominantly sandstone and lack rusty-weathering siltstone. The field relations indicate that these rock types are facies of each other. However, it has not been possible to draw boundaries between the rock types, owing to their gradational and interbedded relationships with each other, the inadequate exposures, and the complex structure in the core of the synclinorium.

Age and Correlation

Two distinct faunal Communities (Table 1) have been recognized in the main part of the Tomhegan. The non-rusty-weathering beds contain a fauna (the "*Amphigenia* Community") characterized by *Amphigenia, Dalejina,* and *"Chonetes" nectus.* The rusty-weathering beds contain a Community characterized by *Globithyris.*

The *Amphigenia* Community is concluded to be of Schoharie age because of the presence of the following forms: *Acrospirifer hercyniae* var. *atlanticus, Charionoides doris, Eodevonaria arcuata, Amphigenia parva.* Spiriferoids of the *A. hercyniae* var. *atlanticus* type are not known in beds of pre-Schoharie age in North America. *Charionoides doris* and *Eodevonaria arcuata* are known only from beds of Schoharie age as are small forms of the genus *Amphigenia.* Boucot and Johnson (1967) have discussed the significance of the *Amphigenia* zone in North America and the reasons for concluding that it is of Schoharie age.

The *Globithyris* Community cannot be accurately dated paleontologically because in this region *Globithyris* ranges from the upper portion of the Tarratine Formation (of Oriskany age) into the main part of the Tomhegan (of Schoharie age), and the genus is also known from the *Etymothyris* zone portion of the York River sandstone, (Boucot, Cumming and Jaeger 1967). However, the structural position of the beds containing the *Globithyris* Community in the main part indicates that they are of Schoharie age, with the possible exception that the lowest of these beds might be intermediate in age between strata of Oriskany and Schoharie age.

Measured section of a portion of the main part of the Tomhegan Formation below the first dam on Misery Stream, Brassua Lake quadrangle (Plate 16). Section measured by A. J. Boucot assisted by Janos Szatai.

	Thickness (feet)
Top of measured section	
Rusty weathering sandstone	5
Covered	156
Rusty weathering sandstone	6
Covered	181
Rusty weathering sandstone	5
Rusty weathering sandstone	6
Rusty weathering sandstone	4
Covered	87
Rusty weathering sandstone	6
Covered	15
Rusty weathering sandstone	5
Covered	123
Sandstone cut by quartz veinlets and shell bed SD-2715 near middle	5
Covered	15
Sandstone cut by quartz veinlets	9
Covered	5
Rusty weathering sandstone	4
Covered	4
Covered	8
Rusty weathering sandstone with shell bed SD-2714 near middle	17
Covered	11
Rusty weathering sandstone with shell bed SD-2713 near base	5
Covered	5
Rusty weathering sandstone	6
Covered	38
Rusty weathering sandstone	17
Total thickness of measured section	748

Measured section including portion of the type section of the main part of the Tomhegan Formation along west shore of Moosehead Lake in Tomhegan Township, Brassua Lake quadrangle in area shown on Plate 17. Section measured by Paul DeVergie assisted by Barbara Boucot.

	Thickness (feet)
Top of measured section	
Rusty weathering sandstone	4
Quartzite with shell bed SD-2756	4
Covered	37
Rusty weathering sandstone with shell bed SD-2755	4
Quartzitic sandstone	3
Rusty weathering sandstone	8
Covered	4
Rusty weathering sandstone	7
Quartzitic sandstone	7
Covered	63
Rusty weathering sandstone	4
Rusty weathering sandstone	5
Rusty weathering sandstone	3
Covered	8
Slate with shell bed SD-2757	32

	Thickness (feet)
Covered	9
Rusty weathering sandstone (50%) and quartzitic sandstone (50%)	12
Rusty weathering sandstone	20
Covered	660
Sandstone	20
Covered	196
Rusty weathering sandstone	29
Covered	97
Sandstone	14
Sandstone	9
Sandstone	18
Rusty weathering sandstone	6
Covered	467
Thin bedded sandstone (½ - 1 inch thick beds)	6
Sandstone (beds 6 - 24 inches thick)	15
Sandstone	10
Covered	19
Sandstone	12
Sandstone	10
Covered	279
Sandstone (beds ½ - 6 inches thick)	4
Sandstone	15
Covered	17
Sandstone	12
Rusty weathering sandstone	8
Covered	265
Rusty weathering sandstone	8
Covered	75
Sandstone	8
Sandstone	16
Covered	3
Sandstone	6
Rusty weathering sandstone	8
Rusty weathering sandstone	21
Sandstone	28
Sandstone with quartz veinlets	4
Rusty weathering sandstone	10
Sandstone	9
Interbedded rusty weathering sandstone (65%) and sandstone (35%)	8
Covered	69
Sandstone	21
Sandstone	28
Rusty weathering sandstone	6
Sandstone	9
Rusty weathering sandstone	12
Sandstone	4
Rusty weathering sandstone	8
Sandstone	4
Sandstone	10
Covered	6
Rusty weathering sandstone	21
Sandstone	4
Rusty weathering sandstone	8
Interbedded sandstone and rusty weathering sandstone	12
Rusty weathering sandstone	12
Rusty weathering sandstone	10
Covered	160
Rusty weathering sandstone	22
Interbedded sandstone (60%) and rusty weathering sandstone (40%)	12
Sandstone	6
Rusty weathering sandstone	7
Sandstone	4
Rusty weathering sandstone	18
Total thickness of measured section	3,096

Measured section of portion of main part of Tomhegan Formation on southeast side of Farm Island, Brassua Lake quadrangle in the area shown on Plate 18. Section measured by A. J. Boucot assisted by Barbara Boucot.

	Thickness (feet)
Top of measured section	
Thin-bedded sandstone	19
Covered	48
Thin-bedded sandstone	16
Sandstone	6
Thin-bedded sandstone	22
Covered	8
Thin-bedded sandstone	5
Covered	22
Thin-bedded sandstone	10
Covered	12
Sandstone	4
Covered	6
Sandstone	14
Covered	18
Thin-bedded sandstone	31
Covered	15
Sandstone	13
Covered	70
Cross-bedded sandstone	47
Covered	9
Sandstone	6
Covered	30
Cross-bedded sandstone	8
Thin-bedded sandstone	8
Covered	22
Sandstone	16
Covered	14
Thin-bedded sandstone	32
Covered	30
Thin-bedded sandstone	53
Covered	88
Sandstone with limonite nodules and shell bed SD-2723	20
Covered	7
Quartzite	31
Covered	402
Thin-bedded quartzite with quartz veinlets	79
Covered	699
Thin-bedded sandstone	5
Covered	5
Thin-bedded sandstone	24
Covered	76
Thin-bedded sandstone	30
Total thickness of measured section	2,080

KINEO VOLCANIC MEMBER
(Pl. 1, Figs. 1-2; Pl. 2, Figs. 1-2; Pl. 3, Figs. 1-2)

Distribution

The rhyolitic volcanic rocks of the Kineo are widely distributed around the edge of the contorted core of the Moose River synclinorium. On the southeast side of this synclinorium the massive felsite of the Kineo stands out as a discontinuous line of hills extending from the Coburn Mountain area northeast to Norcross Mountain. These hills have reliefs ranging from 200 to 800 feet. The rhyolite of Big Spencer Mountain in the core of the Roach River synclinorium is assigned to the Kineo.

Thickness

The stratigraphic thickness of the Kineo is highly varied, ranging from a feather edge to a maximum of about 4,000 feet. In places the thickness changes very rapidly, varying as much as several thousand feet in a distance parallel to strike of less than one mile. The erratic and highly variable thickness of the member is due to its volcanic nature.

Description

The Kineo is made up of a variety of rhyolitic rocks: massive, conchoidally fractured felsite; massive, irregularly fractured felsite containing abundant garnet phenocrysts; dark tuff; light tuff; conglomerate consisting largely of volcanic materials; and flow breccia.

Massive felsite

The large bodies of conchoidally fractured, massive felsite have stratigraphic thicknesses ranging from a feather edge to about 4,000 feet. The smaller felsite bodies range from a feather edge to a maximum of several hundred feet in thickness.

This felsite is blue gray on fresh surfaces and has a chalky-white rind about one-eighth to one-half inch thick on weathered surfaces. In the hand specimen small glassy phenocrysts of quartz are seen to form about 5 percent of the rock, and gray phenocrysts of feldspar about 2 percent. The quartz phenocrysts are usually less than one millimeter in diameter, those of feldspar about 1 to 2 millimeters in diameter. The feldspar phenocrysts weather out to leave rectangular voids. The gray groundmass is very fine-grained. Chaotic flow banding is prominent in some exposures, and amygdules filled with calcite have been observed at Mount Kineo. On some specimens vague outlines of spherulites can be noted. Garnet phenocrysts or columnar jointing are very rare.

Garnet felsite

The massive, irregularly fractured felsite containing abundant garnet phenocrysts has a stratigraphic thickness ranging from a feather edge to 1,000 feet. Like the massive felsite, the fresh rock is blue gray, but the weathered surfaces are greenish white rather than chalky white. Garnet phenocrysts averaging about 2 millimeters in diameter form about 5 percent of the rock, and white feldspar phenocrysts with an average length of about 2 to 3 millimeters form 10 to 15 percent of the rock; quartz phenocrysts are uncommon. Columnar jointing is present in some exposures. The vague outlines of spherulites can be distinguished at some localities and flow banding can be observed at others.

The felsite with columnar jointing northeast of Williams Mountain is intermediate in character between massive felsite and garnet felsite, but it appears to resemble the garnet felsite somewhat more than the massive felsite.

Dark tuff

In exposures, the dark tuff is commonly cut into elongate rectangles by cleavage planes and steeply inclined joints. The tuff is usually associated with bodies of garnet felsite.

The weathered surfaces are greenish white to light gray, resembling those of the garnet felsite; in places a greenish-white rind about one-eighth to one-half inch thick has developed. The fresh rock is a dark blue gray that is considerably darker than the blue gray of the felsites. Angular fragments of felsite make up about 20 to 70 percent of the rock. These felsite fragments are lighter than the dark groundmass. In thin section, some of the felsite fragments appear as pumice. The size of the felsite and pumice fragments is usually no more than a few millimeters, but some fragments reach dimensions of several centimeters. Spherulites are present in some of the fragments of felsite. Devitrified shards of glass can be distinguished in sections of many of these tuffs, and perlite has been observed. At many localities the tuff contains both garnet and feldspar crystals.

The dark tuffs grade compositionally into dark blue-gray mudstone that appears to be very feldspathic, although the "feldspar" grains may be in large part made of felsite. In localities where the tuff is cut by closely spaced cleavage planes the felsite and pumice fragments have been stretched or rotated parallel with the cleavage planes and have sharp, lenticular outlines. The cleavage planes are coated with talcose micaceous minerals.

Light tuff

Light colored tuff occurs at two localities between Blue Ridge and the highest knob on Misery Ridge. Its stratigraphic thickness is estimated to range from a feather edge possibly to 300 or 400 feet, but these figures are based on scattered information and therefore are not accurate.

The light tuff weathers chalky white, in places with a rind of altered material about one-half to one inch thick. The fresh rock is blue gray. Felsite and pumice fragments, with dimensions averaging about a quarter of an inch, make up about 50 percent of the rock and fine-grained volcanic debris the remainder. Devitrified shards are abundant in the groundmass.

Volcanic conglomerate

Conglomerate in which the pebbles consist almost entirely of rhyolitic felsite is abundant in the Kineo. Its stratigraphic thickness ranges from a feather edge to several hundred feet.

In the valley of Misery Stream and north of Warren Camp the conglomerate consists chiefly of well-rounded fragments of felsitic rocks in a fine-grained groundmass. Beds of pebbles are interbedded with

coarse-grained sandstone and medium-grained sandstone, all of which appear to contain a large amount of felsitic material. The pebbles average about 1 inch in diameter, maximum size being a few inches. About 10 percent of the pebbles consist of slate and dark sandstone, the remainder felsite.

Northwest of Smith Pond the conglomerate consists of about 50 percent angular fragments of felsite, including a large amount of perlite, in a matrix of sand-size material. Weathered surfaces of this conglomerate are pitted, owing to the less resistant nature of the pebbles, which average about half an inch in diameter.

Southwest of Little Brassua Lake and on the southeast side of Williams Mountain the conglomerate has a siltstone matrix that may form from 20 to 80 percent of the rock. The pebbles are about 90 percent sedimentary rock (chiefly dark sandstone) and about 10 percent felsite. Rounded to angular in shape, the pebbles attain maximum diameters of about one foot.

On the northwest side of Eagle Mountain the conglomerate contains poorly rounded cobbles of massive felsite, ranging up to a foot in diameter. Here the matrix is gray siltstone.

A single thin bed included within the volcanic conglomerate on Misery Stream near BM 1251, Misery Township, Brassua Lake quadrangle, included fragments of coal from 1 to 3 millimeters in diameter, surrounded by pressure shadows of fibrous quartz. A sample of the coal, obtained by hand picking, floating in a mixture of bromoform and acetone, and washing in acetone, was submitted for analysis. The material was analyzed by J. M. Axelrod (Report No. IWX-489), using the X-ray powder diffraction technique and found "to be amorphous to X-rays . . . on ignition it decrepitated and the fragments burned to a fluffy white ash indicating that the material was mainly carbonaceous."

A second analysis of the coal, using another aliquot, gave the following results:

Analysis of coal from volcanic conglomerate of the Kineo Member (Report No. TWC-4921)

A. Caemmerer, analyst

% C in sample	% C ash-free basis	% H in sample	% H ash-free basis	% micro ash
86.21	93.61	1.08	1.17	7.91
86.32	92.49	1.01	1.08	6.67
86.29	92.85	1.11	1.19	7.07

J. M. Schopf (written communication, 1956) examined a third aliquot and prepared the following report: "The analytic data given Report No. TWC-4921 suggests that the coal probably is anthracite, and certainly not meta-anthracite in rank. Standard rank classification, however, is based on proximate, rather than ultimate values, expressed on a dry basis, mineral-matter-free.

"A polished-surface section of the best coal in its sandstone matrix was prepared, with the hope that some of the original plant tissue structure might be visible if original orientation were maintained. In addition, polished-surface sections of meta-anthracite from Cranston District, Providence County, Rhode Island, and Iron Mountain, Michigan, were made for comparison with higher rank coal, and a similar preparation was made of anthracite from No. 7½ coal bed near Shamokin in the Pennsylvania Western Middle field. The closest comparison is with vitrinized material in the Pennsylvania anthracite. On polishing, the sections of meta-anthracite were found to show evident graphitic carbon with surface characteristics very different from the section of material from Maine.

"The Moose River coal probably is derived from woody tissues, as such tissues are most likely to be deposited in sizeable fragments that could give rise to vitrain. However, no tissue characteristics could be observed in the specimen at hand. A few microscopic mineral inclusions are present and these could be related to original cell lumens, but none are large enough to fill the cavity and protect it from compression. Consequently, the cellular forms are equivocal. The minor amount of inherent striation simply suggests that cellular features might be observed in material only slightly differently preserved.

"Some areas of the sections show a lower reflectance than others and have a tendency to polish out in lower relief. This is evidently not a tissue-limited or a preservational feature; rather, it probably indicates differences in metamorphism. Such variations are possible in coaly pieces in sandstone where pressure extremes may not be applied uniformly owing to "bridging." If this effect is not simply a preparation artifact, it would have some bearing on the apparent rank as determined by chemical methods. Plants large enough to form vitrain as thick as these fragments are not commonly reported in Lower Devonian strata. If additional coaly material from the area could be obtained, some of it might be well enough preserved to retain identifiable botanical features."

Flow breccia

Flow breccia has been observed at two localities, one on the northeast end of Little Kineo Mountain, the other on the northeast side of Big Duck Cove. The thickness at both localities ranges from a feather edge to a maximum of several hundred feet.

The flow breccia, which grades laterally into massive felsite, is similar in appearance to the felsite except that it contains numerous fragments of irregularly-shaped felsite set in a matrix of the same material. The fragments are poorly rounded and sorted, their maximum dimensions being about 1

foot. The seemingly conglomeratic or breccia-like texture of this rock can best be observed on glacially polished or artificially polished surfaces; elsewhere it may be confused with massive felsite.

Contacts

The contact with the overlying main part of the Tomhegan has been described under the discussion of that unit.

The contact with the underlying Tarratine Formation has been seen only on the northeast side of Big Duck Cove. At this one locality flow breccia of the Kineo rests with apparent conformity upon siltstone of the underlying Tarratine.

Facies Relations

On Eagle Mountain the massive felsite grades laterally into flow breccia and upward into felsite conglomerate. On the northeast end of Little Kineo Mountain the massive felsite grades laterally into flow breccia. The massive felsite of Blue Ridge is interpreted as grading southwestward into light tuff, whereas the massive felsite on Misery Ridge is interpreted as grading northeastward into light tuff. The dark tuff and garnet rhyolite southwest of Warren Camp apparently grade into each other laterally, and the tuff contains some fragments of garnet rhyolite. The volcanic rocks southwest of Little Brassua Pond appear to grade into each other laterally. The dark tuff and garnet rhyolite on Cold Stream Pond and in the Cold Stream area appear to grade into each other laterally.

The extrusive nature of the bodies of massive felsite is well demonstrated at both Eagle and Little Kineo Mountains. The garnet rhyolite bodies appear to be closely associated areally with dark tuff and with volcanic conglomerate. It is probable that each of the bodies of massive felsite and each area of garnet rhyolite, together with its associated pyroclastic rocks, represents a local center of volcanic activity. It is inferred that they are all more or less contemporaneous because they all appear at about the same stratigraphic position, but more detailed studies might provide additional information bearing on sequence.

Age and Correlation

The Kineo is bracketed between the Tarratine Formation of Oriskany age and the main part of the Tomhegan Formation, of Schoharie age. Fossils are very rare in the Kineo and occur only at two localities in the conglomerate, as listed in the following table:

Table 2: Fauna of the Kineo Volcanic Member

Taxa	U.S.G.S. Locality No. Loc. SD-2838	Loc. SD-2819
Leptostrophia sp. or *Protoleptostrophia* sp.		x
Globithyris callida	x	
Mutationella parlinensis		x
Plectonotus cf. *P. gaspensis*		x
Elasmonema cf. *E. bellatulum*		x

The fossils from locality SD-2838 are non-diagnostic as far as discriminating between strata of Oriskany and Schoharie age is concerned. The collection from locality SD-2819 was obtained from a boulder in a conglomerate of the Kineo and is most closely related to the *Mutationella* Community of the underlying Tarratine Formation, although *Elasmonema* is locally known only from the main part of the Tomhegan Formation. If the boulder is intraformational, there would exist a strong possibility that the Kineo was of Oriskany age, but it seems more probable that the boulder was eroded from the underlying, partially consolidated Tarratine Formation and redeposited in the overlying Kineo.

The occurrence in some of the conglomerate beds of pebbles of dark sandstone resembling that of the underlying Tarratine Formation indicates that the Kineo may have been deposited after the lithification and subsequent partial erosion of the Tarratine. Cross sections and the field relations suggest that the Kineo was at least partially contemporaneous with the basal portion of the main part of the Tomhegan Formation.

The massive and coarse-grained volcanic rocks that make up the bulk of the Kineo have no counterparts either in the overlying main part of the Tomhegan or in the underlying Tarratine. However, intrusive rocks similar in composition to the volcanic rocks of the Kineo are present in the Tarratine. Its conglomerates containing both volcanic and sedimentary rocks, as well as its tuffs and flows, suggest that the Kineo may have been deposited during a period of volcanism and erosion of older rocks. The volcanic material that occurs in the dark tuffaceous sandstone of the main part of the Tomhegan may have been at least partly derived from the Kineo.

It is concluded that the Kineo is possibly of Schoharie age because of its relation to the associated main part of the Tomhegan, with the reservation that the Kineo could be intermediate in age (i.e., Esopus) between the Tarratine and the main part of the Tomhegan. Beds intermediate in age (Esopus and its correlatives) between strata of Oriskany and Schoharie age have been described from eastern New York (Boucot, 1959) and occur in Gaspé.

Rankin, (1960) has described the welded tuffs of the Traveler Mountain region of eastern Piscataquis County and concluded that they were extruded under non-marine conditions (welded tuffs are concluded by him to occur only above sea level). If the massive felsites of the Kineo Volcanic Member are at all similar environmentally then there is a distinct possibility that all of these felsites occurring above fossiliferous Oriskany age strata in Somerset

and Piscataquis Counties may represent an interval when the region was above sea level (i.e., Esopus time) prior to the onset of marine conditions during the Schoharie interval. The presence of coal fragments is consistent with this interpretation, as is the scanty paleontologic data.

In the Moose River region the Kineo is probably equivalent to the closely associated Heald Mountain Rhyolite. Rhyolites are abundant elsewhere in northern Maine to the northeast and occur in a stratigraphic position that allies them to the Kineo Volcanic Member. These include the rhyolite of Soubunge Mountain (Smith, 1933, p. 226-227) and the Traveler region (Smith, 1930, p. 6-8) which occur immediately above rocks of Oriskany age and are probably of Kineo age. It is possible that the strip between the Traveler region and Heald Mountain during Esopus time was an area of intensive volcanism occurring well above sea level.

HEALD MOUNTAIN RHYOLITE

The massive felsite and dark tuff occurring in the area of Heald Mountain and Grannys Cap, Pierce Pond quadrangle, is designated the Heald Mountain Rhyolite. Heald Mountain is designated as the type area.

Thickness

The maximum thickness of this unit is from 1,000 to 2,000 feet.

Description

The massive felsite, which forms the two linear ridges of Heald Mountain and Grannys Cap, is identical in appearance with the massive felsite of the Kineo Volcanic Member. Flow breccia occurs at the base of the unit at its southwesternmost exposures on the flanks of Heald Mountain (owing to its thickness of 20 feet it cannot be shown on the geologic map). This flow breccia, which is similar in appearance to that of the Kineo Volcanic Member grades upward almost imperceptibly into massive felsite.

The dark tuff which is exposed in the valley of Stony Brook and on the adjacent slopes, contains yellowish, angular fragments of pumice and felsite, about a quarter to a half an inch in diameter, in a fine-grained, dark matrix. The matrix forms about 50 percent of the rock.

Contacts

The upper contact of the Heald Mountain rhyolite has been eroded away.

The lower contact is well preserved at the southwest end of Heald Mountain. At this locality the flow breccia of the unit rests directly on the dark sandstone of the underlying Tarratine Formation. The contact is sharp, interrupted at one spot by a minor high-angle fault with stratigraphic slip of about 5 feet, and shows no evidence of being intrusive. Elsewhere the actual contact is roughly conformable with the underlying Tarratine Formation. Numerous dikes of felsite cut the underlying Tarratine Formation at both extremities of Heald Mountain and may represent feeders, although no direct connections were traced out between any one dike and the massive felsite. The covered interval between exposures of the felsite and the dike nearest the felsite is about one hundred yards.

Facies Relations

The flow breccia, as previously mentioned, grades upward into massive felsite. The dark tuff has not been observed actually to pass into bodies of felsite, but the field relations strongly suggest, by proximity in particular, that the tuff is closely related to the felsite.

Age and Correlation

The Heald Mountain Rhyolite rests upon the Tarratine Formation, but the Misery Quartzite Member is not present beneath the felsite. On lithological grounds it would be logical to assign the Heald Mountain Rhyolite to the Kineo Volcanic Member. However, the absence of the Misery Quartzite Member opens up the possibility that the Heald Mountan Rhyolite might be slightly older than the Kineo and might, in fact, be a member of the Tarratine Formation which was situated beneath the Misery Quartzite Member prior to the erosion of the quartzite. However, there is an additional possibility that the Misery Quartzite Member was not deposited this far southwest and is here represented by dark sandstone indistinguishable from that of the main part of the Tarratine Formation, upon which the Heald Mountain Rhyolite rests. A third possibility is that the Heald Mountain Rhyolite is a shallow intrusive equivalent of the Kineo, but the presence of flow breccia and associated dark tuff makes this very unlikely in the writer's opinion. It is concluded that the Heald Mountain Rhyolite is a lateral equivalent of the Kineo, with the reservation that it might be slightly older and might represent the onset of Kineo-type volcanism in the region.

TARRATINE FORMATION

(Pl. 4, Figs. 1-2; Pl. 5, Figs. 1-2; Pl. 6, Fig. 1)

The term Tarratine Formation is used here as defined by Boucot (1961, p. 165-169), with the addition to it of some strata in the Roach River synclinorium. The Formation has three subdivisions: a Misery Quartzite Member near the top of the Formation, a McKenney Ponds Limestone Member locally at the base of the Formation, and the main part of the Formation.

MAIN PART OF THE TARRATINE FORMATION

Distribution

The Tarratine Formation is exposed on the southeast, southwest, and northwest sides of the Moose River synclinorium, but it is missing from the northeast side, where its place is taken by the laterally equivalent Seboomook formation. The most southwestern exposures are in the area just west of Spencer Lake (Spencer quadrangle). From here it extends along the northwest side of this synclinorium through the Enchanted Pond area and the Long Pond area to the Moose Brook Islands (North East Carry quadrangle). Along the southeast side it extends from the Spencer Lake area northeast to the area east of Norcross Mountain (North East Carry quadrangle).

In the Roach River synclinorium the Tarratine Formation is present from the vicinity of Big Pine Pond (Ragged Lake quadrangle) on the north and southwest of Jewett Pond (Moosehead Lake quadrangle) in the core of the synclinorium. An isolated patch is also present in the Kokadjo area (First Roach Pond quadrangle).

Thickness

The thickness of the Tarratine Formation ranges from a feather edge to about 10,000 feet. There are two maxima* (Plate 19), one of about 10,000 feet in the Enchanted Pond area and a second of about 8,000 feet in the Big Duck Cove area. Lesser thicknesses occur between these two areas. Southeast and northwest of the core of the Moose River synclinorium the thickness rapidly diminishes to a feather edge. Southwest of Spencer Lake and northeast from the Big Duck Cove area the thickness also rapidly diminishes. These rapid changes in thickness are most striking at the northeast end of the synclinorium, where the 8,000 foot thickness in the Big Duck Cove area diminishes to a feather edge in a distance of about 3 miles to the northeast, and to about 1500 feet in a distance of about 3 miles to the northwest as the sandstone of the Tarratine grades laterally into the Seboomook Formation.

Similar rapid changes in thickness have been determined in the Roach River synclinorium (Plate 19). The syncline centered about Big Spencer Mountain contains a maximum thickness of about 10,000 feet of Tarratine Formation which rapidly shrinks to a feather edge northeasterly. In the Kokadjo area about 9,000 feet of the unit is present which completely disappears along strike both to the northeast and southwest. These precipitous changes in stratigraphic thickness cannot be satisfactorily explained on a structural basis; they are closely related to a rapid shift in facies from the dark sandstone of Tarratine lithology to the cyclicly-layered slate and sandstone of Seboomook lithology.

* The isopach maps of the Tarratine and Seboomook Formations were constructed by taking the thicknesses derived from structural cross-sections and plotting them directly on the quadrangle base maps. No account was taken of shortening due to folding or of possible flowage during folding. It is probable that this procedure will introduce a certain degree of error in the results. However, the great thicknesses involved and the overall trends, regardless of some subsequent structural disturbance, are more easily visualized in diagrams of this type. If detailed data becomes available having to do with the precise amount of flowage and shortening or lengthening involved in the various folds it would be possible to refine the isopach maps, although it is doubtful if our first order approximations would be significantly affected.

Description

The main part of the Tarratine Formation consists almost entirely of interbedded dark sandstone, slate and siltstone. Exposures of the main part are commonly elongate in shape, their steep sides formed by northeast-trending cleavage and bedding planes, their ends formed by steeply-dipping northwest-trending joints. Most of these exposures have weathered surfaces of dark brown to gray, with a thin rind (about one-eighth to one-quarter inch thick) of chalky, tan material. Some exposures are stained by coal-black oxides of manganese.

Dark sandstone

From study of areas mapped in detail it is estimated that dark sandstone makes up over 90 percent of the main part of the Formation. This sandstone, blue-gray on fresh surfaces, is well indurated and quartzitic. The thickness of individual beds ranges from fractions of an inch to 50 feet. Individual beds do not have great lateral extent, no one bed having been recognized at more than a single outcrop, and some beds occur as lenses within the breadth of a single exposure. The sandstone consists largely of fine to medium sand-sized angular quartz grains with a minor amount of feldspar. The medium sand-sized constituents make up 50 to 80 percent of the rock, and the remainder is fine-grained, dark material. Cross-bedding, ripple marks, pseudo-nodules, and shell lenses are uncommon. Thin layers of slate are interbedded throughout.

The following analysis of sandstone from the main part of the Tarratine was made:

Analysis of dark sandstone from the main part of the Tarratine Formation.

Analysis ID-20850 (Report No. IDC-13)

Harry H. Hyman, analyst; carbon determination by Charlotte Warshaw

	Percent
SiO_2	90.84
Al_2O_3	3.46
Fe_2O_3	0.37
FeO	2.23
MgO	0.47
CaO	0.14
Na_2O	0.40
K_2O	0.57
H_2O-	0.10
H_2O+	0.99

TiO_2		0.19
CO_2		0.08
P_2O_5		0.04
S		0.02
MnO		0.07
C		0.05
	Total	100.02
	Less O for S	0.01
	Final total	100.01

Locality: Parlin Gorge (see Plate 20), Long Pond quadrangle.

The analysis emphasizes the high percentage of quartz and the relatively low percentages of feldspar and micaceous minerals.

Slate

The slate of the main part is thoroughly cleaved and is less resistant to weathering than the sandstone. The fresh rock is gray. Shell beds, which rarely extend more than a few tens of feet laterally, are more common in the slate than in the sandstone. Shell beds in both the slate and the sandstone rarely have a thickness of more than about 6 inches and at most places are about 2 or 3 inches in thickness.

Siltstone

The siltstone of the main part is black on fresh surfaces; weathered surfaces, unlike the rest of the unit, are gray to dark gray or rusty. The rock consists of about 20 to 30 percent angular quartz grains and a small amount of feldspar, in a matrix of fine-grained, dark material.

Contacts

The contact of the Tarratine Formation with the overlying Tomhegan Formation has been discussed in connection with the Tomhegan.

The base of the main part of the Tarratine is in contact with the McKenney Ponds Limestone Member, Hobbstown Formation, the basement complex, the Lobster Mountain Volcanics, undifferentiated strata of Silurian age, and the Seboomook Formation. At one locality the main part of the Tarratine grades into the underlying limestone of the McKenney Ponds Limestone Member, but at a second locality the two units exhibit a sharp, disconformable contact. The contact with the laterally gradational and underlying Seboomook Formation is completely gradational, over an interval of as much as 200 feet, the boundary being drawn where the cyclicly-layered slate and sandstone of the Seboomook form more than 50 percent of the exposure. Contacts with the other underlying units are concluded to be unconformable.

Facies Relations

The lower part of the Tarratine Formation, near the contact with the Seboomook Formation shows thinner bedding and includes a greater percentage of slate interbeds than the upper part of the Formation. The middle and upper parts of the main part in the area between Enchanted Pond and Spencer Lake are decidedly more massive, with some individual beds reaching 50 feet in thickness and beds of 10 to 20 feet being common. Such beds are displayed in the cliffs bordering Enchanted Pond and also on the slopes of Hedgehog Mountain. Rusty-weathering siltstone is most abundant in the upper part of the Formation, particularly in the interval between the Misery Quartzite Member and the Tomhegan Formation.

Age and Correlation

The Tarratine Formation, as a unit, is characterized by the presence in abundance of the brachiopod *Leptocoelia flabellites*.

The Formation contains three distinct animal Communities (Table 3). Two can be dated as of Oriskany age; the third can be dated as late Lower Devonian and is concluded to be also of Oriskany age because of its stratigraphic position. The three Communities, in any one section, are commonly arranged in a definite sequence, but boundaries drawn between the Communities do not correspond to lithologic boundaries used in mapping the region.

The normally lowest Community which is designated the *Beachia* Community is characterized by the presence of the following species: *"Chonetes" canadensis*, *Beachia thunei*, *Platyceras ventricosum*, and *Follmanella mainensis*. The middle Community, which is designated the *Mutationella* Community, is characterized by the presence of the following species: *Chonostrophiella complanata*, *Antispirifer harroldi*, and *Mutationella parlinensis*. The upper fauna, which is designated the *Globithyris* Community, is characterized by the presence of *Globithyris*.

The lower two Communities contain many species in common, although the diagnostic species are not commonly found together except near the boundary between the two Communities. The upper Community is very restricted in number of species and has almost none in common with the lower two Communities, although a few localities near the boundary between the middle and the upper Community contain a mixture of species common to both.

The stratigraphic position of the boundaries between these Communities does not parallel the mapped lithologic boundaries, there being in fact considerable variance between the two. In general, the *Beachia* Community is associated with the thinner-bedded more fine-grained rocks, the *Mutationella* Community with the thicker-bedded medium-grained rocks, and the *Globithyris* Community with the rusty-weathering siltstones. Mapping of the Tarratine on the basis of these distinctions, however, was not found to be practicable.

Careful inspection of Plate 30 demonstrates that the position of the *Mutationella* and *Beachia* Communities boundary is stratigraphically quite variable as compared with either the base of the Misery Quartzite Member or the Tarratine-Seboomook contact. In addition, in the Enchanted Pond region, *Beachia* Community occurrences are present both above and below *Mutationella* Community occurrences. These relations further reinforce a Community as opposed to a stratigraphic or structural interpretation of the observed relationships.

The *Mutationella* and *Beachia* Communities are of Oriskany age, as indicated by the presence of *Acrospirifer murchisoni, Plicoplasia plicata, "Chonetes" canadensis*, and *Beachia* — taxa which elsewhere are known only in strata of Oriskany age. *Leptostrophia, Chonostrophiella, Nanothyris, Rensselaeria,* and *Mutationella* are currently restricted to strata of pre-Schoharie age in the Appalachian Province. *Costispirifer, Protoleptostrophia,* and *Globithyris* are not known below strata of Oriskany age elsewhere. *Antispirifer* has not been positively recognized outside of northern Maine. *Rhodocrinus nortoni* Goldring, known only from float of Tarratine lithology, belongs to the *Beachia* Community, and according to the late Dr. Edwin Kirk (oral communication, 1951), is similar to an undescribed crinoid (U.S.N.M. No. S-4616, Springer Collection) from the Ridgeley Sandstone of Cumberland, Maryland, which also is of Oriskany age.

Measured section in upper portion of the Tarratine Formation, including Misery Quartzite Member. The section was measured along the course of Parlin Stream, Long Pond quadrangle in the area shown on Plate 20. Section measured by A. J. Boucot assisted by John Matthews.

	Thickness (feet)
Top of measured section	
Sandstone	19
Rusty weathering slate with shell bed SD-2716 near middle	15
Covered	260
Top of Misery Quartzite Member	
Quartzite	46
Covered	15
Quartzite	5
Quartzite	5
Sandstone	5
Covered	45
Quartzite	13
Covered	22
Quartzite	26
Base of Misery Quartzite Member	
Covered	40
Sandstone	8
Covered	15
Sandstone	7
Sandstone	24
Sandstone	17
Sandstone	29
Sandstone	41
Sandstone — analysis ID-20850	30
Sandstone	36
Sandstone	10
Sandstone with shell bed SD-2717	21
Sandstone, one-third slate, with shell bed SD-2718	53
Sandstone	40
Sandstone	37
Sandstone	30
Sandstone	30
Sandstone	6
Sandstone	6
Covered	16
Sandstone	7
Covered	28
Sandstone	4
Sandstone with shell bed SD-2719	3
Covered	6
Sandstone and shell bed	6
Sandstone and shell bed	11
Sandstone and shell bed SD-2720	6
Sandstone and shell bed	4
Sandstone and shell bed	4
Sandstone and shell bed	3
Covered	21
Slate with shell bed SD-2721 at top and SD-2722 near base	12
Total thickness of measured section	1,087

Measured section of the lower portion of the Tomhegan Formation, the type section of the Tarratine Formation (including the type section of the Misery Quartzite Member) and the upper portion of the Seboomook Formation; all situated in and adjacent to the Railroad cut just east of Tarratine, Brassua Lake quadrangle in the area of Plate 15. Section measured by William Joyner assisted by Barbara Boucot.

	Thickness (feet)
Top of measured section	
Rusty weathering slate	21
Thin-bedded sandstone	5
Rusty weathering slate	10
Sandstone	7
Interbedded sandstone (65%) and slate (35%)	44
Banded sandstone with shell bed (SD-2690) at top	31
Interbedded slate (65%) and sandstone (35%) with analysis ID-21050	17
Rusty weathering slate	39
Sandstone	14
Covered	13
Sandstone	16
Covered	126
Top of Tarratine Formation and base of Tomhegan Formation	
Fine-grained sandstone	5
Interbedded sandstone (70%) and slate (30%)	10
Sandstone	5
Covered	9
Fine-grained sandstone	8
Covered	143
Quartzite	8
Covered	450
Top of Misery Quartzite Member	
Quartzite	8
Covered	68
Quartzite	24
Covered	72
Quartzite	7
Interbedded sandstone (50%) and slate (50%)	23

	Thickness (feet)
Hematite-stained quartzite	9
Covered	113
Quartzite	85
Covered	64
Hematite-stained quartzite	13
Base of Misery Quartzite Member	
Interbedded sandstone (70%) and slate (30%)	10
Slate	8
Sandstone	40
Quartzite	14
Sandstone	126
Covered	37
Thin-bedded sandstone	8
Covered	14
Thin-bedded sandstone	16
Sandstone with shell bed (SD-2691) near base	51
Covered	28
Sandstone	11
Covered	22
Sandstone	30
Covered	23
Sandstone	34
Covered	130
Thin-bedded sandstone	117
Covered	11
Thin-bedded sandstone	75
Sandstone	107
Covered	109
Thin-bedded sandstone	235
Covered	8
Thin-bedded sandstone	44
Covered	19
Thin-bedded sandstone	110
Covered	7
Thin-bedded sandstone	35
Covered	8
Thin-bedded sandstone	143
Covered	45
Sandstone	9
Covered	11
Thin-bedded sandstone	10
Covered	22
Sandstone with shell bed (SD-2692) just above center	45
Covered	28
Sandstone	15
Covered	18
Sandstone	25
Covered	14
Thin-bedded sandstone	244
Interbedded sandstone (70%) and shale (30%) with shell beds (SD-2693 to SD-2700)	88
Sandstone	12
Interbedded sandstone (60%) and slate (40%)	98
Sandstone	14
Covered	9
Interbedded sandstone (70%) and slate (30%)	12
Covered	27
Sandstone	25
Covered	23
Sandstone	60
Covered	9
Interbedded sandstone (50%) and slate (50%)	18
Covered	10
Sandstone	26
Covered	17
Sandstone	26
Covered	11
Interbedded sandstone (60%) and slate (40%)	48
Sandstone	30
Sandstone with shell bed (SD-2702) near base	32
Sandstone with shell bed (SD-2703) near base of upper half	57
Interbedded sandstone (75%) and slate (25%)	17
Sandstone	10
Interbedded sandstone (60%) and slate (40%)	9
Sandstone with shell bed (SD-2704) at base	18
Interbedded sandstone (60%) and slate (40%)	12
Sandstone with shell bed (SD-2705) at top	19
Interbedded sandstone (60%) and slate (40%) with shell beds SD-2706 to 2708	25
Sandstone with shell bed (SD-2709)	18
Interbedded sandstone (70%) and slate (30%)	10
Sandstone with shell beds SD-2710 and SD-2711	19
Covered	143
Thin-bedded sandstone	30
Base of Tarratine Formation and top of Seboomook Formation	
Covered	120
Slate	19
Covered	25
Slate	23
Covered	19
Slate	40
Covered	7
Slate	22
Covered	26
Slate	14
Covered	16
Slate	31
Covered	9
Slate	22
Covered	157
Interbedded slate (70%) and sandstone (30%)	66
Covered	22
Slate	23
Total thickness of measured section	5,242

Measured section of Tarratine Formation along Enchanted Stream, south from Enchanted Pond, Pierce Pond Quadrangle, Somerset County, Maine. Section measured by Harry Perry and reproduced with his permission.

	Thickness (feet)
Top of measured section	
Finely-laminated, slightly calcareous massive quartzite	20
Sandstone containing quartz veins	2
Greenish altered diorite with chilled contacts	177
Covered	7
Gray, massive, fine-grained, metamorphosed quartzite	26
Finely laminated quartzite	15
Non-laminated quartzite	5
Covered	3
Sandstone with 6 inch slate bed near middle	5
Covered	1
Bedded quartzite and some slate with shell bed near middle	44
Covered	4
Bedded quartzite with slate towards bottom	18
Covered	185
Dark gray, thin-bedded, fucoidal slate	8
Thin bedded quartzite and slate containing pyrite cubes	16
Covered	1
Calcareous quartzite with slaty partings	8
Covered	11
Quartzite with some slate beds and shell beds	25
Total thickness of measured section	581

Measured section of Tarratine Formation along eastern cliffs of Shutdown Mountain, Pierce Pond Quadrangle, Somerset County, Maine. Section measured by Harry Perry and reproduced with his permission.

	Thickness (feet)
Base of measured section	
Sandstone	10
Covered	3
Bluish-gray, fine-grained, hard, massive quartzite	17
Covered	2
Sandstone	19
Sandstone capped by 6 inch shale bed	33
Sandstone with thin contorted slate beds near center	10
White vein quartz	1
Sandstone	2
Sandstone	8
Sandstone	28
Sandstone	9
Bluish-gray, fine-grained, hard, massive quartzite	22
Covered	10
Sandstone with several thin shell beds	30
Sandstone with contorted slate bed at top	24
Covered	5
Sandstone with shell bed in lower half	19
Bluish-gray, fine-grained, hard, massive quartzite with thin shell bed near middle and thin contorted slate beds in lower third	19
Covered	0.5
Sandstone with fossil beds near top and 6 inch slate bed at top	8
Sill	1
Sandstone with white vein quartz	2
Covered	2
Massive, bluish-gray, fine-grained, hard quartzite, with some slate and thin shell beds near bottom of upper half	27
Sandstone with two sparsely populated shell beds	8
Thin bedded, gray-slate with thin interbeds of quartzite	2
Slate and thin beds of sandstone	3
Slabby slaty quartzite — upper contact gradational to slate	2
Thinly bedded dark gray slate	8
Covered	1
Sandstone	3
Thinly bedded sandstone and some slate	1
Sandstone with shell beds heavily populated with *Leptocoelia flabellites* with six inches slate at top	9
Sandstone with some slate at top	5
Sandstone	1
Slate	0.5
Slate	2
Total thickness of measured section	351

MISERY QUARTZITE MEMBER

This unit occurs as a widespread, relatively thin sequence of interbedded quartzite, dark sandstone, and slate situated near the top of Tarratine Formation in about half of the area mapped as Tarratine. Where the Misery is present, it divides the Tarratine into an upper and lower portion. In the absence of the Member, this division cannot be recognized.

Distribution

The Misery Quartzite Member is widely distributed on the southeast side of the Moose River synclinorium. On the northwest side it has been recognized only at the southwest end. On the southeast side, the most northeasterly exposures recognized are at Big Duck Cove (North East Carry quadrangle). From Big Duck Cove southwest to the Enchanted Pond area it is intermittently exposed. On the northwest side of the synclinorium the Misery is present between Enchanted Pond and the railroad section point at Brassua, Sandwich township, Brassua Lake quadrangle, but northeast of Parlin Stream (Long Pond quadrangle) the unit has not been recognized and is inferred to be absent. The unit is also absent in the syncline that includes Grannys Cap and Heald Mountain (Pierce Pond quadrangle).

The Misery Quartzite Member is also present about the southeast side of the core of the Roach River synclinorium.

Thickness

The thickness of the Misery Quartzite Member ranges from 4 feet to about 500 feet. The maximum thickness is located in the southwest half of the Moose River synclinorium, in particular southwest of Parlin Stream.

Description

The characteristic rock type of the Misery is a quartzite, making up 30 to 50 percent of the total thickness of the unit, but because of its more resistant nature the impression gained in the field is that it constitutes nearer 100 percent. The non-quartzite interbeds are commonly observable only in the few artificial exposures or in deeply incised stream courses.

The quartzite is light gray on both weathered and fresh surfaces and is cut by numerous small, randomly-oriented veinlets of milky quartz. The quartzite is made up of about 90 percent angular, fine to medium sand-sized quartz grains plus about 10 percent feldspar and slate grains. The beds are usually about 2 to 5 feet thick, and bedding is very obscure in the quartzite itself. Cross-bedding is present but never prominent. The individual quartzite beds are lens-like; they thicken and thin very rapidly and cannot be traced for more than a short distance along strike. Red staining of the quartzite by hematite has been observed at a few localities, but is not typical of the unit. Pebble conglomerate occurs at a few outcrops. The pebbles average about a quarter of an inch in diameter and consist chiefly of quartzite, with about 10 percent of felsite and slate. These pebbles are moderately well rounded.

The following analysis of quartzite from the Misery Quartzite Member was made:

Analysis of quartzite from the Misery Quartzite Member

Report No. IWC-374 (Lab. No. 53-2447C)

S. M. Berthold, analyst; alkalies by flame photometer by J. M. Dowd

		Percent
SiO_2		97.58
Al_2O_3		1.63
Fe_2O_3		0.03
MgO		0.02
CaO		0.17
Na_2O		——
K_2O		——
H_2O+		——
H_2O-		——
TiO_2		0.05
P_2O_5		0.03
?	Loss	0.42
	Total	99.91

Locality: East ninth of Brassua Lake quadrangle, Somerset County, Maine, 1.46 miles S 61° E. from the outlet of Brassua Lake.

The dark sandstone, siltstone, and slate of the Misery Quartzite Member are like those of the main part of the Tarratine Formation.

Contacts

Both upper and lower contacts of the Misery Quartzite Member are gradational with the main part of the Tarratine Formation. The boundaries are drawn at the upper and lower occurrences of white quartzite.

Facies Relations

The Misery Quartzite Member is situated in the upper half of the main part of the Tarratine Formation and is a facies of it. At Big Duck Cove one 4-foot bed of quartzite is present, and east of Mount Kineo there are two 4-foot beds of quartzite. To the southwest, the occurrences of quartzite are much thicker, although not continuous along strike. Northeast of Parlin Stream the unit has not been observed and is presumably absent. Southwest of Enchanted Pond, the quartzite is also absent, but it has not been determined whether this absence is due to non-deposition or to removal prior to the extrusion of the Heald Mountain Rhyolite. Individual beds cannot be traced from one set of exposures to the next, and the impression gained in the field is that the quartzites of the Member are actually a series of discontinuous lenses occurring at about the same stratigraphic position in the upper part of the Tarratine Formation. The top of the Misery Quartzite Member is from 500 to 1,000 feet below the base of the Tomhegan Formation.

The facies relationships of the Misery Quartzite Member in the Roach River synclinorium are similar to those in the Moose River synclinorium.

Age and correlation

No fossils have been found in the Misery Quartzite Member, but fossils of Oriskany age have been found in the main part of the Tarratine Formation both above and below the quartzite. The Misery Quartzite, is, therefore, of Oriskany age.

McKENNEY PONDS LIMESTONE MEMBER

The term is used here as defined by Boucot (1961, p. 167-168).

Distribution and Thickness

The McKenney Ponds Limestone Member has been recognized only in a narrow belt extending southwest and northeast of the McKenney Ponds. At the ponds the Member has a maximum stratigraphic thickness of about 200 feet; away from that area it thins to a feather edge.

Description

The rocks of the McKenney Ponds Limestone Member form a narrow, linear valley that parallels the contact of the main part of the Tarratine with the underlying basement complex and the Lobster Mountain Volcanics. The valley has the aspect of an old roadcut, with a relatively flat roadbed and high banks on either side. Less than 30 feet wide at most places, it was formerly used by lumbermen as a sluiceway for transporting logs. The valley was formed by solution of the limestone of the McKenney Ponds Limestone Member; along one side the overlying dark sandstone and slate of the main part of the Tarratine stand up as a sharp-edged cuesta, and on the other side the basement complex has assumed similar form.

Limestone is the most abundant and characteristic rock type in this member but calcareous arkose, conglomerate, slate, and dark sandstone also occur. The limestone is white-weathering, has rounded surfaces formed by solution, is cut by steeply inclined joints which are filled with coarsely crystalline calcite, is massive and indistinctly bedded. It is fossiliferous and consists largely of pelmatozoan debris, but it also contains a variable amount of non-calcareous, clastic material. This non-calcareous clastic material consists chiefly of poorly rounded quartz grains plus a variable percentage of feldspar grains. The grain size of the limestone is relatively coarse, the grains averaging several millimeters in diameter.

On the northeast side of the McKenney Ponds the limestone grades laterally into arkosic sandstone of the lower part of the Tarratine Formation within a distance of no more than a few hundred feet.

Arkose is present near the base of the unit. At several exposures northeast of the McKenney Ponds the arkose contains about 30 percent cream-colored feldspar fragments, well-rounded and frosted quartz grains having an average diameter of about 1 millimeter, and a large amount of calcareous cement. The feldspar fragments are angular and unweathered. Some of the exposures of arkose contain up to fifty percent of cream-colored, angular feldspar grains. A similar arkose on the northwest side of the McKenney Ponds contains about 20 percent shell debris, as well as quartz, feldspar and a few poorly-rounded pebbles of granitic and felsitic rocks.

Subordinate amounts of slate and dark sandstone occur in the McKenney particularly at its upper contact with the overlying sandstone of the main part of the Tarratine Formation. The slate and dark sandstone are well indurated and relatively thin-bedded, the beds averaging a few inches to a foot in thickness. Fresh surfaces are blue-gray, weathered surfaces gray. The dark sandstone, which is somewhat quartzitic, contains angular quartz grains and a small percentage of feldspar grains in a matrix of fine-grained, dark material. At some exposures the slate is rusty-weathering and contains nodules of marcasite which weather out to leave irregular voids. At other exposures the slate contains rounded quartz and feldspar grains up to a quarter of an inch in diameter and is also rusty weathering. Slate of the latter type is closely associated with the underlying dark Lobster Mountain Volcanics.

Contacts

The upper contact with the main part of the Tarratine Formation has been described under discussion of that unit.

The basal portion of the Member consists of arkose and slate, which rest respectively upon granitic rocks of the basement complex and upon the Lobster Mountain Volcanics of possible Ordovician age. These basal beds have a thickness not exceeding about 20 feet. Exposures of the contact of the granitic basement and the arkose were not identified, probably because of the difficulty in distinguishing between indurated arkose and granitic basement where the arkose is little more than broken granitic fragments that are well indurated. The actual contact between the slate and the underlying Volcanics is covered. The presence of abundant pebbles and coarse felsitic and granitic debris with lithologies similar to those in the underlying units makes clear that these basal beds were derived from the underlying rocks.

Facies Relations

The McKenney Ponds Limestone Member appears to be a relatively thin layer consisting largely of calcareous shell debris that accumulated locally in a limited area where large amounts of non-calcareous material were not available. The basal arkose and slate, which are about 20 feet thick, are overlain by massive beds of limestone, which in turn are overlain gradationally by dark sandstone and slate.

On the northeast side of the McKenney Ponds the limestone grades laterally into arkosic, dark sandstone belonging to the main part of the Tarratine Formation. Southwest of the McKenney Ponds the limestone is replaced laterally by interbedded slate and dark sandstone belonging to the main part of the Tarratine Formation.

Age and Correlation

The largely gradational upper contact and the gradational lateral contacts of the McKenney Ponds Limestone Member suggest that it is closely allied to the lower part of the Tarratine Formation. The fauna (Table 4) which is of Oriskany age includes *Beachia, Hipparionyx,* and *Acrospirifer* cf. *A. murchisoni*. However, the presence of *Hedeina macropleura* in the fauna is anomalous because almost everywhere else in the Appalachian Province this genus is not known above strata of Helderberg age. Possibly the specimens of *Hedeina* were reworked from previously existing strata of Beck Pond Limestone age which have now been totally removed, or alternatively the genus may have a slightly longer stratigraphic range in this region than elsewhere. Although at some exposures the Beck Pond Limestone has about the same appearance and stratigraphic position as the McKenney, the Beck Pond fauna is older than the McKenney fauna.

The following fossils have been identified from the McKenney Ponds Limestone Member:

Table 4

Fauna of the McKenney Ponds Limestone Member

	U.S.G.S. Locality No.		
	SD-2810	SD-2806	SD-2864
Dalejina sp.	x	x	x
Costellirostra sp.		x	
Platyorthis planoconvexa	x	x	
Hedeina cf. *H. macropleura*	x	x	
Acrospirifer cf. *A. murchisoni*	x	x	x
Metaplasia cf. *M. paucicostata*		x	
Meristella lata	x	x	
Leptaena "rhomboidalis"		x	
Leptostrophia sp. or *Protoleptostrophia* sp.			x
Protoleptostrophia sp.	x		
"Schuchertella" becraftensis	x	x	
Hipparionyx sp.	x	x	
Beachia thunei	x	x	x
Platyostoma ventricosum		x	

Klapper (written communication, 1968) reports as follows on a single conodont isolated by the late Wilbur Hass in 1950:

U. S. Geol. Survey collections.

Slide labeled as follows:

A. J. Boucot
Summer, 1949
N. B. 288
Conodont register 11014

Pierce Pond quadrangle, Maine
1/4 mile SW of McKenney Ponds

1 specimen of *Icriodus*, probably an *Icriodus latericrescens* but too fragmentary for identification below the specific level. *I. latericrescens*, as a species, ranges throughout the Lower and Middle Devonian.

From a Community point of view the McKenney Ponds Limestone Member fauna belongs to Boucot and Johnson's (1967) Big Shell Community. The Big Shell Community is a near shore Community present from Gaspé to West Texas representing shallow water conditions.

SEBOOMOOK FORMATION

The term Seboomook Formation is used here as redefined by Boucot (1961, p. 169-171), and includes a Camera Hill Greenstone Member, plus a Bear Pond Limestone Member (Boucot, Harper, Rhea, 1959, p. 8). The Seboomook is the most widespread unit in northern Maine. It is synonymous and continuous with both the Temiscouata Slate of the Eastern Townships, and the Fortin Slate of southern Gaspé to the northeast; both the St. Juste Group of the Eastern Townships, and the Compton of the Eastern Townships; and the Gile Mountain Formation of eastern Vermont, the Littleton Formation of western New Hampshire, and the Leyden Argillite of western Massachusetts (in addition to equivalent rocks in Connecticut) to the west and southwest. The "Granite Talus Member" (Boucot, Harper, Rhea, 1959, p. 9) is here considered too insignificant to warrant recognition as a formal unit.

Distribution

The Seboomook Formation is widely distributed in both the Moose River and Roach River synclinoria. It forms a wide swath on the northwest and northeast sides of the Moose River synclinorium, as well as a narrow belt on the southeast side from northeast of Somerset Junction (Brassua Lake quadrangle) southwest to Spencer Stream (Spencer quadrangle), where the belt of outcrop broadens considerably. Southwest of the Spencer Stream area the outcrop belt again narrows before finally pinching out in the vicinity of Jim Pond (Spencer quadrangle). In the Roach River synclinorium the Seboomook is widely distributed about the core of the structure, except for a small portion on its northwest side, and to the southwest into the middle of the Moosehead Lake quadrangle where it is cut off by the Squaw Mountain pluton and older strata occurring in northeast plunging folded structures.

Thickness

The total thickness of the Formation ranges from a feather edge to 20,000 feet. The thickness of the Formation at its type section is about 10,000 feet, and the additional thickness is measured from cross-sections compiled from scattered exposures adjacent to the type section. The original maximum thickness, before erosional removal of the overlying strata is unknown. The isopach map (Plate 21) gives a summary of the thickness distribution.

Description

The sandstone and slate of the Seboomook Formation form discontinuous lines of low ridges and hills that are aligned parallel to the general northeast strike of the bedding and cleavage. The discontinuous nature of these ridges and hills is due to the prevalence of doubly-plunging folds and steeply-dipping joints striking at right angles to the bedding and cleavage.

The sandstone and slate are characteristically cyclicly-layered, the layers giving exposures a varved appearance. The sandstone layers grade up into the fine-grained slate bands. The thickness of the layers ranges from fractions of an inch to several feet, but 1 to 3 inches is average. Where sandstone predominates, the layers approach maximum thickness; where slate predominates, the reverse is true. Both rocks are blue-gray where fresh and gray where weathered, the slate being darker than the sandstone. The sandstone is composed of angular quartz grains in a ground-mass of fine-grained dark material. The quartz grains make up about 50 to 80 percent of the rock.

The following analyses of slate and of layered sandstone and slate were made:

Chemical Analyses of slate and layered sandstone and slate from the Seboomook Formation

	(1)*	(2)*
SiO_2	60.13	66.99
Al_2O_3	16.43	14.89
Fe_2O_3	0.81	0.72
FeO	5.76	4.51
MgO	3.44	2.77
CaO	1.19	0.77
Na_2O	1.68	1.84
K_2O	3.32	2.98
H_2O-	0.13	0.04
H_2O+	3.97	3.12
TiO_2	0.92	0.84
CO_2	1.50	0.48
P_2O_5	0.19	0.13
S	0.03	——
MnO	0.08	0.07
C	0.44*	——
Total	100.02	
Less O for S	0.01	

Carbon	0.00	
Final total	100.01	100.15

(1) Harry H. Hyman, U. S. Geological Survey, Analyst (Gray slate)

* Carbon determinations by Charlotte Warshaw

Report No. IDC-13 (Lab. No. ID-20850)

Gray slate from Seboomook Formation, railroad cut ½ mile west of boundary between Long Pond and Jackman Townships, Somerset County, Maine

(2) M. Balazs, U. S. Geological Survey, Analyst Seboomook Formation banded slate and dark sandstone at B. M. 1136 North East Carry quadrangle, Piscataquis County, Maine (IDS-153 #C509)

The above analyses are suggestive of an originally shaly rock which was low in ferric iron, lime and carbon dioxide as compared to the average shale presented by Clarke (1924, p. 34), and relatively higher in ferrous iron and magnesium. Possibly this indicates that a higher percent of chlorite and a lower amount of calcite was originally present, although metamorphism might account for diminution of CO_2 and the reduction of ferric iron to ferrous.

The base of the Seboomook above the Hardwood Mountain Formation in the Little Big Wood Pond area (Attean quadrangle) contains arkose with pebbles of granitic rocks and felsite as well as cyclicly banded slate and dark sandstone. Several exposures in the northwest arm of Moosehead Lake contain scattered rounded pebbles of felsite and greenstone, up to several inches in diameter, in a matrix of slate. These pebble beds are about 10 feet thick.

Contacts

The contact of the Seboomook with the overlying Tarratine Formation is gradational (see discussion of main part of Tarratine Formation).

The base of the Seboomook Formation rests unconformably upon the Hardwood Mountain Formation, the basement complex, the Beck Pond Limestone, the Hobbstown Formation, a variety of pre-Silurian rocks, the Lobster Lake Formation, and the Whisky quartzite, as well as a variety of undifferentiated Silurian and Early Devonian strata. The actual contact with the underlying Hardwood Mountain Formation north of Little Big Wood Pond is marked by slate containing pebbles of limestone derived from the Hardwood Mountain plus a few pebbles of granite similar to that in the adjacent basement complex.

Boucot, Harper, and Rhea (1959, p. 7-9) have described the unconformable contact observed between the basal strata of the Seboomook and the underlying Beck Pond Limestone, and between the basal Seboomook which here includes a "Granite Talus Member" and the pre-Silurian granitic basement complex.

Facies Relations

No systematic stratigraphic variations have been noted. Several exposures in the northwest arm of Moosehead Lake contain scattered, rounded pebbles of felsite and greenstone up to several inches in diameter, but the rarity of this rock type does not permit any stratigraphic use to be made of it. Between Little Big Wood Pond and the Canada Falls - Rockwood Road the proportion of slate in the Seboomook reaches 95 percent. On the northern shores of Moosehead Lake slate makes up more than 50 percent of the unit. In the area of Seboomook Dam, however, arenaceous, dark, cyclicly bedded, sandstone makes up more than half of the unit.

The facies relations of the Seboomook with the Tarratine Formation are described under the discussion of the thickness of the Tarratine Formation and its facies relations.

Age and Correlation

The fauna of the Seboomook Formation (Table 5) is similar to the *Beachia* Community of the Tarratine Formation, with the exception that *Atrypa "reticularis,"* not found in the Tarratine Formation, occurs at one locality. Perkins (1925, p. 375) cites *Monograptus* sp. from an exposure of the Seboomook Formation on the Canada Falls - Rockwood Road. His specimen (Locality G, Yale Peabody Museum No. 25842) has been re-examined by Boucot and concluded to be of very doubtful origin. It certainly cannot be concluded safely to be a graptolite, much less *Monograptus*.

Nearly every fossil occurrence in the Seboomook Formation is located within a mile of exposures of the Tarratine Formation. Of the occurrences more than a mile from the Tarratine strata, one contains *Plicoplasia plicata* (these specimens were originally cited as *Leptocoelia flabellites* by Boucot, 1954, p. 148, but have now been restudied), and the others contain only *Leptocoelia*. The presence of *Leptocoelia flabellites* is presumptive evidence in this region of an Oriskany, or possibly Late Helderberg, age for the Seboomook Formation, and the presence of *Beachia* is corroborative evidence. However, owing to the distribution of the fossil localities in the Seboomook, the lower unfossiliferous part of the Formation may be older. This situation has been demonstrated in the Beck Pond area where Helderberg age fossils have been obtained in the basal few inches of the Seboomook (Boucot, Harper, and Rhea, 1959, p. 2-8).

The following taxa have been found in the basal Seboomook Formation at outcrop 12 (Boucot, Harper, and Rhea, 1959, p. 8): *Atrypina* sp., *Spinoplasia gaspensis*, *Orthostrophia* cf. *O. strophomenoides*, *Levenea* cf. *L. subcarinata*, and an unidenti-

fied rhynchonellid. This faunule is suggestive of a New Scotland, Helderberg age.

Strata of Helderberg age have also been found below the Seboomook in the Fish River Lake area[1] of Aroostook County and in the Spider Lake area[2] of Piscataquis County. The Ludlow and Pridoli age Hardwood Mountain Formation, which occurs disconformably below the Seboomook, would locally limit such a downward range of the Seboomook to the Pridoli as is the case with similar localities in northern Maine and adjacent parts of Quebec.

[1] personal communication, E. L. Mencher, 1966.
[2] personal communication, B. A. Hall, 1966.

CAMERA HILL GREENSTONE MEMBER

This term is used here as defined by Boucot (1961, p. 170-171).

Distribution and Thickness

The dark volcanic rocks of the Camera Hill Greenstone Member are exposed in the central portion of the Spencer quadrangle, where they are commonly found on the tops and the lower slopes of the higher hills within the belt of exposure belonging to the Seboomook Formation. The stratigraphic thickness of this unit ranges from a feather edge to about 400 feet.

Description

On weathered surfaces, the rock of the Camera Hill Greenstone Member is gray to rusty brown, with a rind (about 1/8 to 1/4 inch thick) of chalky material that probably represents weathered feldspar. Fresh surfaces are felsitic and show a gray green to dark green color. The rock fractures irregularly. Scattered phenocrysts of greenish feldspar are visible at some exposures. The base of the body on Camera Hill is vesicular, the individual vesicles having a diameter of about a quarter of an inch. Well-defined volcanic textures and structures have not been observed, but the tabular form of the bodies and their seemingly conformable attitude with the enclosing sedimentary rocks suggests these bodies are of volcanic origin rather than being sills.

Contacts

The actual contacts of the Camera Hill have not been observed, but field relations indicate that they are conformable. On Camera Hill, the basal 20 feet of the unit is vesicular, suggesting that it may be the bottom of a flow.

Facies Relations

The Camera Hill Greenstone Member consists of a series of discrete bodies of dark volcanic material in the upper part of the Seboomook Formation. The Member is equivalent to part of the upper Seboomook Formation, but the actual transition has not been observed.

Age and Correlation

The Camera Hill is bounded above and below by the Seboomook Formation of Oriskany age. It is thus also of Oriskany age.

BEAR POND LIMESTONE MEMBER

The Bear Pond Limestone Member of the Seboomook Formation has been described previously by Boucot, Harper and Rhea (1959; 1966). It is here also included in the Seboomook Formation.

Distribution and thickness

Only one exposure of the unit is known in the vicinity of Bear Pond (Spencer quadrangle). The maximum observed thickness is about twenty feet.

Description

The unit has been previously described in some detail by Boucot, Harper, and Rhea (1959; 1966). It consists of a bioclastic, gray weathering limestone rich in clastic debris.

Contacts and Facies Relations

The contacts of the Bear Pond have not been observed, but its map position necessitates including it within the Seboomook Formation. At first it might seem peculiar to assign so much formal significance to this single exposure. However, the wide distribution of the Seboomook Formation in the northern Appalachians makes every bit of significant data relevant to its total age range have great importance due to the great rarity of fossils within the Seboomook in its entire area of outcrop as well as that of its synonyms elsewhere in the northern Appalachians.

Age and Correlation

The Bear Pond Limestone Member is of probable New Scotland, Late Helderberg age as shown by its rich brachiopod fauna (Boucot, Harper, and Rhea, 1966, p. 41).

BECK POND LIMESTONE

The term Beck Pond Limestone is used here as originally defined by Boucot, Harper, and Rhea (1959), and as used by Boucot (1961, p. 173-174) and by Boucot, Harper, and Rhea (1966). It includes a complex assemblage of members restricted to a small area on the west side of Beck Pond (Spencer quadrangle).

Distribution

The Beck Pond Limestone has been recognized only in the vicinity of Beck Pond.

Thickness

It is difficult to be certain about the thickness of the Beck Pond Limestone but the data in Boucot,

Table 5

Fauna of the Seboomook Formation exclusive of the Beck Pond area

U.S.G.S. Locality No. / Taxa	Platyorthis planoconvexa	Atrypa "reticularis"	Leptocoelia flabellites	Acrospirifer murchisoni	Costispirifer sp.	Salopina n. sp.	Leptostrophia sp. or Protoleptostrophia sp.	"Schuchertella" becraftensis	"Chonetes" canadensis	Chonostrophiella complanata	Beachia thunii	Platyostoma ventricosum	Plicoplasia plicata	Loxonema sp. 1	Meristella lata
2725			x	x			x		x		x				
2737			x												
2748			x												
2760	x		x				x	x			x				x
2761		x	x				x				x				
2774				x											
2788			x												
2801			x						x						
2848			x												
2849			x						x						
2857	x		x	x			x		x					x	
2858			x				x								
2870	x		x				x				x				
2877			x				x								
2879			x									x			
2880			x												
2883			x				x								
2884						x					x	x	x		x
3089			x	x					x				x		x
3091			x												
3093	x														
3094			x					x							
3229	x		x												
3481			x									x	x		
3482	x		x	x	x				x	x	x		x		x
3486	x		x						x		x				
4010			x												
4012	x		x												

Harper, and Rhea (1959; 1966) suggests that a figure of about 300 feet is nearly correct.

Description

The Beck Pond Limestone was divided by Boucot, Harper, and Rhea (1959) into five, complexly related members. Member 1 is predominantly coarse, gray-green quartzose limestone; Member 2 consists chiefly of stromatoporoid biostromes interbedded with small amounts of gray-green, quartz-rich limestone; Member 3 is similar to Member 1; Member 4 is light-colored granite-boulder conglomerate with a calcareous, arkosic matrix; and Member 5 is similar to Member 4 but contains more calcareous material. In addition, dark boulder conglomerate (Boucot, Harper, and Rhea, 1959, p. 19-20) was tentatively included with the Beck Pond by Boucot, Harper, and Rhea (1966).

Contacts

The basal contact of the Beck Pond has not been observed, but the available information (Boucot, Harper, and Rhea, 1966 and 1959) strongly suggests that it rests unconformably upon the basement complex. The upper contact has been described under the Seboomook Formation. Boucot, Harper, and Rhea (1966) make a strong point that the Beck Pond Limestone was deposited during New Scotland time on a basement complex topographic high during the same time interval as the basal Seboomook was being laid down in an adjacent topographic low. Before New Scotland time was concluded the adjacent topographic low had been filled by the Seboomook which then lapped unconformably over the Beck Pond Limestone.

Facies Relations

Facies relations between the five members of the Beck Pond Limestone have been discussed and illustrated at some length by Boucot, Harper, and Rhea (1959; 1966).

Age and Correlation

The brachiopods of the Beck Pond Limestone, and in particular those of Member 5, indicate a New Scotland, Helderberg age as summarized by Boucot, Harper, and Rhea (1959), with additional information presented later (1966, p. 41) by the same authors. Oliver (1960) has studied corals from Members 1 (Locality SD-6301, outcrop 22) and 5 (Locality SD-3499, outcrop 10) and finds that they are consistent with a Helderberg age although not useful for zonal purposes.

The presence of two distinct animal Communities in Members 1 and 5 as shown by both the brachiopods and the corals (Boucot, Harper, and Rhea, 1966, p. 41) indicates the difficulty of correlation without detailed information on the evolution of the groups involved.

PARKER BOG FORMATION
(Pl. 12, Fig. 1)

The term Parker Bog Formation is used here as defined by Boucot (1961, p. 173). It is the same rock unit as the "Interbedded limestone and tuff" of Boucot, Griffin, Denton, and Perry (1959, p. 9), and probably includes their (1959, p. 9-10) "Interbedded limestone and slate."

Distribution

The Parker Bog Formation is known only from the type locality in the Parker Bog (Pierce Pond quadrangle), and below Gore Rapids (Spencer quadrangle).

Thickness

The thickness of the Formation is about two hundred feet in both areas of outcrop.

Description

The exposures of this Formation at Parker Bog Ponds consist of interbedded light-gray limestone and white-weathering, flinty felsite. The beds range in thickness from a few inches to a few feet. The felsite is strongly jointed and fractured, whereas the limestone is not nearly as shattered by joints. A few fractures in the limestones are coated with either cross-fiber or slip-fiber asbestos. The mineral forming the asbestos is reported (Report No. IWM-509) by Marie L. Lindberg to be "a member of the tremolite-actinolite series" based on an X-ray powder diffraction film. The limestone forms rounded surfaces due to solution, and contains abundant pelmatozoan columnals, although most of the calcareous material is very fine-grained. The felsite is white weathering, has a white chalky rind about one-quarter inch in thickness, and is gray and flinty on fresh surfaces. The fractures which cut the felsite are coated with a thin film of yellowish material. Fossils are preserved in the felsite, but with the exception of pelmatozoan columnals they have not been recovered from the interbedded limestone. Topographically this formation does not stand out from those either above or below. Although no phenocrysts have been observed in the rock, it is suspected that the felsite was a waterlain, fine-grained tuff, as evidenced by the inclusion of marine fossils. Examination of the felsite by means of thin sections and X-ray powder diffraction pictures indicates that it consists largely of oligoclase, quartz, and calcite plus actinolite and chlorite. The actinolite forms small needles which penetrate the equigranular oligoclase. It is likely that this rock is a metamorphosed andesitic tuff.

Lime-Silicate hornfels from Parker Bog Formation
Lab. No. 146865

	Percent
SiO_2	53.3
Al_2O_3	9.4

Fe_2O_3	1.0
FeO	2.5
MgO	7.6
CaO	19.4
Na_2O	.17
K_2O	4.1
TiO_2	.60
P_2O_5	.05
MnO	.08
H_2O	.81
CO_2	.36
Sum	99.00

Southeast ninth of Spencer Quadrangle, Somerset County, Maine on north bank of Spencer Stream S20E from the outlet of Horseshoe Pond.

Analyzed by: Paul L. D. Elmore
Katrine E. White
Samuel D. Botts

The similar appearing felsite in Gore Rapids, which is yellowish rather than gray, consists of an interlocking aggregate of diopside crystals plus small amounts of garnet, quartz, and micaceous minerals, as determined from examination of thin sections and X-ray powder diffraction pictures. The Gore Rapids occurrence is a contact metamorphosed equivalent of the rock occurring at the type locality.

Contacts

The upper contact of the Parker Bog Formation with the Seboomook Formation has not been observed, but the attitude of bedding in both Formations is parallel suggesting that they are conformable, although not ruling out the possibility of disconformity. The lower boundary of the Formation in both areas of exposure is a thrust fault (see Boucot, Griffin, Denton, and Perry, 1959, for details of the Gore Rapids area).

Facies Relations

It was noted that felsite forms massive five to ten foot beds at Gore Rapids, where limestone is subordinated, whereas at Parker Bog Ponds the proportions of both are about equal. It is presumed that this is a facies relationship, and might be interpreted as indicating that the source of the felsitic material lay nearer the Gore Rapids occurrence than to the Parker Bog Ponds locality. Fossils are rarer in the Gore Rapids occurrence than in that at the Parker Bog Ponds, but the significance of this observation is not apparent due to inadequate sampling at either site.

On a regional basis it is probable that the Parker Bog Formation is a facies of the Beck Pond Limestone, and possibly the basal, Helderberg age, portion of the Seboomook Formation.

In the southeasternmost corner of the Pierce Pond quadrangle, to the northeast and on the opposite flank of the Lobster Mountain Anticlinorium, Post (locality 1318) has collected *Orthostrophia* cf. *O. strophomenoides* identified by Boucot from a largely volcanic conglomerate which may be closely related to the Parker Bog Formation.

Age and Correlation

The fauna of the Parker Bog Formation (Table 6) is of Early Devonian age as indicated by the presence of *Coelospira* and *Strophonella* of the *S. punctulifera* type. The stratigraphic position beneath the Seboomook Formation indicates that the Parker Bog Formation should be of Oriskany or earlier Lower Devonian age. In this region strata of Lower Helderberg age have not been recognized, although younger Helderberg age beds are widely distributed. It is concluded that the fauna of the Parker Bog Formation is most consistent with a New Scotland, Helderberg age. It is noteworthy that *Strophonella, Eatonia*, and *Coelospira* have not been recognized in this region from strata of Oriskany age, although they are present at many localities in beds of Helderberg age.

Table 6

Fauna of the Parker Bog Formation

Locality	SD-3487	SD-3477
Dalejina? sp.		x
Isorthis sp.	x	
Eatonia? sp.		x
Coelospira sp.	x	x
Meristella? sp.	x	x
Leptaena "rhomboidalis"		x
Leptostrophia? sp.		x
Strophonella cf. *S. punctulifera*		x

HOBBSTOWN FORMATION
(Pl. 6, Figs. 2-3; Pl. 7, Figs. 1-2)

The term Hobbstown Formation is used here as defined by Boucot (1961, p. 174-176). It consists of a widely distributed main part and a lower conglomerate member present in a restricted area on Spencer Mountain (Spencer quadrangle).

Distribution

The rocks assigned to the main part of the Hobbstown Formation occur in the following areas: west end of Bean Brook Mountain, T4 R7, Long Pond quadrangle; Hobbstown Township, Spencer quadrangle; east shore of King and Bartlett Lake, northwest of Camera Hill, just east of first swamp below Baker Pond, and southwest end of King and Bartlett Mountain, all of these localities being located in T4 R5, Spencer quadrangle. Albee and Boudette (1965) have located similar rocks, which Boucot assigns to the Hobbstown, on the east slope of Sally Mountain, Attean quadrangle. The lower conglomerate member is known only on Spencer Mountain, Hobbstown Township, Spencer quadrangle.

LOWER CONGLOMERATE MEMBER

Thickness

The stratigraphic thickness of the lower conglomerate member is from a maximum of two hundred feet to a feather edge.

Description

The lower conglomerate member consists of roundstone conglomerate. The pebbles and boulders in this conglomerate vary in size from fractions of an inch to several feet in diameter. They are well rounded to poorly rounded with well rounded pebbles being most abundant and giving the rock the appearance of a puddingstone. Topographically the lower conglomerate member stands out as a ridge-forming unit where it is underlain by the weak, calcareous rocks of the Hardwood Mountain Formation, and overlain by relatively poorly indurated conglomerate and sandstone of the main part of the Hobbstown Formation. Exposures of the lower conglomerate member are massive, rounded where glaciated, and steep-sided where cut by steeply dipping joints. Bedding is very obscure. The exposed surfaces of the rock are white-weathering due to the alteration of the feldspars in both felsite and granitic pebbles plus fine grained clastic feldspar grains in the interstitial material between the pebbles. The felsite pebbles weather to a bone-white, chalky color, and the granitic pebbles weather in such a fashion that the more resistant quartz grains stand out in relief from the chalky, white feldspar which has weathered back relative to the quartz. The granitic pebbles and cobbles make up about fifty to seventy percent of the coarse clastic debris and the felsitic material the bulk of the remainder. A few cobbles of calcareous rocks, similar to those making up the Hardwood Mountain Formation, are present, and when very calcareous, weather out to form spherical cavities in the outcrop. Deformation has resulted in severe flattening, indenting, and fracturing of the pebbles. The felsitic pebbles appear to behave in a more plastic manner, being flattened, against the more resistant granitic pebbles. The felsite pebbles are lithologically similar to the light felsites associated with the Lobster Mountain Volcanics in the Chain Lakes quadrangle.

Rhyolite pebble from Lower Conglomerate Member of Hobbstown Formation
Lab. No. 146864

	Percent
SiO_2	72.7
Al_2O_3	13.5
Fe_2O_3	.7
FeO	.48
MgO	.44
CaO	2.3
Na_2O	5.8
K_2O	1.4
TiO_2	.20
P_2O_5	.04
MnO	.09
H_2O	.86
CO_2	1.9
Sum	100

North ninth of Spencer Quadrangle, Somerset County, Maine, in southeast corner of the ninth, midway between the "*9*" of 2009-foot hill and the western edge of the 2000 foot contour on that hill.

Analyzed by: Paul L. D. Elmore
Katrine E. White
Samuel D. Botts

The interstitial material consists of fine to coarse-grained, quartzitic, argillaceous sandstone. The clastic grains in the sandstone are angular for the most part, with a few poorly rounded ones included, and consist chiefly of quartz plus about ten to fifteen percent feldspar. Interstitial to the sand grains is about ten to thirty percent of fine-grained, dark argillaceous material.

The granitic pebbles present in the lower conglomerate member consist of material very similar to that present in the basement complex and presumably were derived from it.

Contacts

The upper contact of the lower conglomerate member, exposed on the northeast side of the unnamed pond northwest of Spencer Mountain, is gradational with the main part of the Hobbstown Formation. Interbeds of roundstone conglomerate, coarse, arkosic sandstone, and angular conglomerate occur in the contact zone, which has a total thickness of about twenty feet.

The nature of the lower contact is discussed under the Hardwood Mountain Formation.

Facies Relations

The lower conglomerate member is inferred to grade laterally into the main part of the Hobbstown Formation as indicated by thinning in a southeasterly direction while maintaining a gradational contact with the overlying main part of the Hobbstown Formation.

Age and Correlation

The two fossil collections (Table 7) obtained from the lower conglomerate member of the Hobbstown Formation were both collected from a four inch bed which immediately overlies the contact with the underlying Hardwood Mountain Formation. Unfortunately, although the fauna is of Ludlow or Pridoli age, it is not possible to be sure whether or not the fossils are a life assemblage or a death assemblage. Due to the broken and disarticulated condition of many of the elements in the fauna, associated as it

is with scattered granite pebbles, it is likely that it represents a death assemblage. It is concluded that this assemblage was derived, by reworking of the underlying sediments, from the Hardwood Mountain Formation and actually represents a lag gravel of shell debris which is considerably older than the containing bed. It is concluded that the lower conglomerate member is at least of Tonoloway age (Pridoli) but is more likely as young as the lower part of the Seboomook Formation which is of Helderberg and Oriskany (Lower Devonian) age; the latter being the probable age of at least a portion of the main part of the underlying Hobbstown Formation northwest of Camera Hill and also on the west end of Bean Brook Mountain.

Table 7

Fauna of the Lower Conglomerate Member of the Hobbstown Formation

Taxa	U.S.G.S. Locality No. SD-2712	SD-3479
Dolerorthis n. sp.	x	x
Dolerorthis cf. *D. hami*		x
Dolerorthis? sp.		x
Ptychopleurella sp.		x
Resserella sp.		x
Dicaelosia sp.		x
Dalejina sp. 1		x
Isorthis sp.		x
Stegerhynchus n. sp.	x	x
Atrypa cf. *A. tennesseensis*		x
Atrypa cf. *A. arctostriata*		x
Nanospira? sp.		x
Delthyris cf. *D. kozlowski*		x
Nucleospira sp.		x
Leptaena "rhomboidalis"		x
Unidentified coarse ribbed chonetid		x
" fine- " "		x
" leptostrophid		x
Limbinaria cf. *L. muricata*		x
Aitilia sp.		x
Garniella sp.		x
Tubulibairdia sp.		x
Tropidodiscus sp.		x
"Euomphalopterus" gasconensis		x

The presence of *Aitilia* sp. and *Limbinaria* cf. *L. muricata* indicates that the ostracod fauna of the lower conglomerate member is closely allied to that of the underlying Hardwood Mountain Formation, which is similar to that of the Tonoloway Formation, as discussed under the Hardwood Mountain Formation. The gastropod is known elsewhere from the graptolite-bearing, Ludlow age Gascons Formation.

The brachiopod fauna of the lower conglomerate member is unlike any others found in northern Maine. The general aspect of the brachiopods is similar to that of the Henryhouse Formation of Oklahoma and the Brownsport Group of Tennessee. *Dolerorthis* cf. *D. hami*, *Ptychopleurella* sp., *Resserella* sp., *Dalejina* sp. 1, *Isorthis* sp., *Atrypa* cf. *A tennesseensis*, *Atrypa* cf. *A. arctostriata*, *Nanospira?* sp., *Delthyris* cf. *D. kozlowski*, and *Nucleospira* sp. are similar to forms occurring in both the Henryhouse and the Brownsport. However, this similarity cannot necessarily be construed as meaning that the fauna from Maine is of the same age until more is known about the stratigraphic range of this fauna. Tentatively, however, the best course is to consider that the ostracod fauna of the lower conglomerate member indicates a correlation with the Tonoloway Formation and the brachiopod fauna with the Henryhouse and the Brownsport. There seems no reason to question the fauna as being of Ludlow-Pridoli age. The possible equivalency with other Ludlow-Pridoli age units in this region, like the Lobster Lake Formation, Lake Aylmer Shale, and Cranbourne Series is not known because of ignorance of the latter faunas.

MAIN PART OF THE HOBBSTOWN FORMATION

Thickness

The thickness of the unit as known on the west end of Bean Brook Mountain is from a feather edge to about two hundred feet; in Hobbstown Township the maximum thickness is about fifteen hundred feet with the top missing due to erosion; on the east shore of King and Bartlett Lake the thickness is from a feather edge to about one hundred feet; northwest of Camera Hill the thickness is from a feather edge to about two thousand feet; east of the first swamp below Baker Pond the thickness is less than ten feet to a feather edge; on the southwest end of King and Bartlett Mountain the thickness is from a feather edge to about two hundred feet.

In summary it is clear that the main part of the Hobbstown Formation has a very erratic thickness, as well as areal distribution, but that stratigraphic thicknesses of both a few hundred and a few thousand feet are present locally.

Description

The rocks of the main part of the Hobbstown Formation are almost entirely coarse-grained arkose and conglomerate containing poorly-rounded pebbles and cobbles. Topographically these rocks do not stand out from either the sedimentary or basement complex rocks with which they are associated but tend to occur below the crests of hills topped by basement complex, with other sedimentary rocks on the lower slopes. Both conglomerate and arkose are white-weathering due to the large amount of contained feldspar which alters to form a chalky rind. The fresh rocks are blue-gray, gray and dark-green in color. The clastic grains in both the arkose and in the interstitial sand-size material between large fragments in the conglomerate consist of fine to coarse-grained quartz grains with about ten to

thirty percent feldspar. The sand-size grains are usually imbedded in a dark argillaceous, fine-grained groundmass. The bulk of the large pebbles and cobbles are made up of a variety of basement complex granitic rocks. However, most of the conglomerates contain a few percent of felsite, calcareous siltstone, and limestone cobbles. The calcareous rocks are similar lithologically to those in the Hardwood Mountain Formation, the siltstone tending to occur as platy fragments and the limestone as rounded cobbles or pebbles. Conglomerate and arkose are interbedded at some localities, whereas at others no evidence of interbedding is observed. Some of the exposures of coarse arkose also include scattered boulders of granitic material. On the southeast and northwest sides of Spencer Mountain the conglomerates are notably coarser, bedding very obscure and boulders up to twelve feet in diameter have been observed, than to the northwest where the conglomerate fragments tend to be more rounded, and contain a larger amount of calcareous material both as pebbles and as detrital grains in the interstitial material.

Contacts

The upper contact, on the west side of Bean Brook Mountain, with the Tarratine Formation is not exposed. The upper contact in the type area is not available due to erosion of the original capping of younger sedimentary rocks. On the east side of King and Bartlett Lake, on the southwest end of King and Bartlett Mountain, and northwest of Camera Hill the contact is probably conformable but is not exposed.

The contact with the underlying Attean Quartz-monzonite was studied in a core obtained from a borehole (FMB) situated one-third mile northeast of Grace Pond, Pierce Pond quadrangle, Somerset County. The core contact is located at 322½ feet. The description of this section of core is as follows:

323½ ft. to 330 ft.

An igneous rock presumably a greenstone similar to the one labeled in Bulletin 1111E as Siluro/Ordovician greenstone volcanic type (Lobster Mountain Volcanics) underlying the Tarratine and overlying the Attean quartz-monzonite.

322½ ft. to 323½ ft.

This is a pyritic arkose. Unconformable upon Lobster Mountain Volcanics.

322 ft to 322½ ft.

Arkosic coarse sandstone including some fine-grained purple fluorite.

321 ft. to 322 ft.

Mudstone.

321 ft.

Unidentified brachiopod.

319 ft. to 321 ft.

Pyritic mudstone.

303 ft. to 319 ft.

Calcareous mudstone and siltstone with minor thin-bedded bioclastic limestone.

Debris of brachiopods was noted at 314½ ft., 314 ft., 309½ ft., 306 ft., 305½ ft., 303 ft.

Favositid corals were noted at 309½ ft. and 303½ ft.

298½ ft. to 303 ft.

Consists of limestone, some of which is a little arkosic particularly in the 301 - 301½ ft. interval.

301½ ft. also included an unidentified brachiopod as well as at 299 ft. Some of these fragmentary brachiopods were spiriferids of the *Acrospirifer murchisoni* type but the identifications are not certain.

290½ ft. to 298½ ft.

A coarse calcareous arkosic sandstone.

291 ft. to 292 ft.

Pyritic and high in silt.

Fragmentary brachiopods were observed in 291½ ft. and 291 ft. 291½ ft. is the base of the Tarratine Formation. The aforegoing units between the greenstone and the Tarratine should be assigned to the Hobbstown Formation as the limestone is too thin to be considered part of the McKenney Ponds Formation despite the fact that the fauna appears grossly similar. Conformable Hobbstown—Tarratine contact.

290½ ft. to the top of the core, the unit consists of fine-grained dark sandstone and mudstone of typical Tarratine Formation lithology.

A body of fine-grained green colored rhyolite similar to those seen as dykes and sills in Parlin Gorge is present from 246 ft. to 269¾ ft. The contact at 269¾ ft. is clearly cross cutting.

At 87 ft. *Metaplasia* is present. The sequence present in this core is very similar to that found by Delaney on the west side of Bean Brook Mountain.

Klapper (written communication, 1968) isolated conodonts from limestone in this core and concluded that they are correlative with the basal Hobbstown limestone on Bean Brook Mountain. Klappers' report is as follows:

Core from Maine labeled FMB No. 1284

295 - 297′	*Icriodus* sp. indet.
297 - 300′	*Spathognathodus* sp. aff. *S. steinhornensis* *Ozarkodina denckmanni* *Belodella* sp.
300 - 302′	*Spathognathodus* sp. aff. *S. steinhornensis* *Belodella* sp.
302 - 305′	*Icriodus* sp. indet. *Spathognathodus* sp. aff. *S. steinhornensis* *Ozarkodina denckmanni* *Belodella* sp.

It is suggested that the core from 297 - 305′ correlates with the Bean Brook Mountain sample on the basis of the identity of the *Spathognathodus*.

Additional collection, made in 1967 by Boucot and Forbes, from Delaney's locality provided more specimens of *Meristella* sp. in the basal arkose and also *Acrospirifer* cf. *murchisoni* (USNM loc. 13590). An overlying four foot thick bed of limestone, similar in lithology to that observed in the core taken to the southwest, yielded *Acrospirifer* cf. *murchisoni*, *Beachia thunii*, *Hipparionyx* sp., *Plicoplasia* sp., *Platyceras* sp., and *Coelospira* sp. (USNM loc. 13591). The age of this limestone faunule is Oris-

kany; the fauna being similar to that recorded from the McKenney Ponds Limestone Member of the Tarratine.

Klapper (written communication, 1968) isolated a conodont faunule from the limestone which correlates with beds in Nevada which include the time span of the Oriskany. Following is Klapper's report: Limestone near base of Hobbstown Formation (USNM loc. 13591).

5139 grams processed

Icriodus latericrescens huddlei Klapper and Ziegler
Spathagnathodus sp. aff. *S. steinhornensis* Ziegler
Belodella sp.
Acodina sp.

"This subspecies of *Icriodus* ranges in central Nevada from the *Spinoplasia* Zone (Siegenian) through the *Eurekaspirifer pinyonensis* Zone (Emsian). The specimens in the Bean Brook sample are most like those in the *Spinoplasia* Zone. I would not rule out a correlation with the overlying *Trematospira* Zone (Siegenian) because of difficulty in distinguishing the kind of *huddlei* in the *Trematospira* Zone from those in the *Spinoplasia* Zone.

"The *Spathognathodus* is probably a new species, and thus does not contribute to an extra-Maine correlation."

Conglomerate and arkose of the Hobbstown Formation can be seen in actual contact with the basement complex at a number of localities in the Spencer quadrangle. In the Long Pond quadrangle on the west side of Bean Brook Mountain, T4 R7 are exposures of conglomerate and arkose in which the coarse debris is lithologically similar to that of the basement complex exposed a few hundred feet to the west. However, the actual contact has not been observed. On the southeast side of Spencer Mountain, Hobbstown township, Spencer quadrangle, and on the crest to the northwest, occur arkose, and conglomerate made up largely (up to ninety-five percent) of granitic debris which is lithologically similar to that exposed nearby in the granitic basement complex. One block of granite with a diameter of twelve feet was observed on the southeast ridge of Spencer Mountain associated with conglomerate. On the northeast side of the bog immediately below the outlet of Baker Pond, T5 R6, Spencer quadrangle, are basement complex exposures partly mantled with conglomerate containing a few cobbles of limestone resembling that of the Hardwood Mountain Formation. Joints within the basement complex at this locality are filled with conglomeratic debris consisting largely of basement complex rock types present in the same outcrop (Pl. 6, figs. 2, 3). On the southwest end of King and Bartlett Mountain, T4 R5 are two areas of outcrop in which cobbles and boulders of basement complex lithology rest on massive granitic rocks of the basement complex. About three-quarters mile northwest of Camera Hill is a ridge held up by dark granitic rocks which are overlain to the southeast by arkose assigned to the Hobbstown Formation. The granitic rocks adjacent to the contact are massive; a few yards to the southeast their joints are filled with silty debris; a few yards further the corners of the blocks are rounded, still further there is a gradation into conglomerate consisting almost entirely of dark granitic cobbles and boulders similar to those on the ridge but including a few limestone cobbles. A few more yards to the southeast the strata consist entirely of coarse arkose. On the east shore of King and Bartlett Lake, Spencer quadrangle, are several exposures consisting of granite cobbles similar in lithology to the nearby granitic rocks of the basement complex.

Albee (oral communication, 1967) reports that the conglomerate on Sally Mountain rests unconformably upon and was largely derived from the underlying granitic basement complex.

Facies Relations

The Hobbstown Formation northwest of Camera Hill, as mapped, has gradational lateral relations with the Seboomook Formation, but it is possible that the Hobbstown Formation at this locality is a lense of arkosic debris unconformably underlying the Seboomook Formation. On Spencer Mountain, as previously mentioned the conglomerate pebbles and cobbles of the Hobbstown Formation become better rounded towards the northwest as bedding becomes more distinctly developed, and a larger percentage of calcareous material is incorporated in both large fragments and sand-size debris.

Age and Correlation

Because of the almost total absence of fossils, except in pebbles of calcareous rocks, which appear to have been derived from the underlying Hardwood Mountain Formation, the main part of the Hobbstown Formation is difficult to date. As detailed earlier the precise dating of the Lower Conglomerate Member is unsure because its fossils cannot be proved to be indigenous. The presence of *Meristella* sp., found in 1959 by J. B. Thompson, Jr. (USNM Loc. No. 12788) in a gravel pit at the southwest end of the Hobbstown body northwest of Camera Hill (1/4 mile NE of where road crosses outlet of Little Jim Pond) substantiates an Early Devonian age for at least one part of the unit. J. R. Delaney also found *Meristella* sp. (USNM Loc. No. 13559) in the Hobbstown on the west end of Bean Brook Mountain (written communication, 1967). The field relationships of the rocks assigned to the Hobbstown Formation to stratigraphic units which have been well dated are obscure and interpretive. However, it is clear that the Hobbstown Formation underlies both the Seboomook and Tarratine Formations wherever the units are seen together, and also overlies the Hardwood Mountain Formation wherever that unit is associated with it.

The relationship of the Hobbstown Formation to the Beck Pond Limestone is unknown. Additional collections, made in 1967 by Boucot and Forbes, from Delaney's locality provided more specimens of *Meristella* sp. in the basal arkose and also *Acrospirifer* cf. *murchisoni* (USNM Loc. 13590). An overlying four foot thick bed of limestone, similar in lithology to that observed in the core taken to the southwest, yielded *Acrospirifer* cf. *murchisoni, Beachia thunii,* and *Coelospira* sp. (USNM Loc. 13591). The age of this limestone faunule is Oriskany; the fauna being similar to that recorded from the McKenney Ponds Limestone Member of the Tarratine. It is concluded, therefore, that the Hobbstown is of Tonoloway (Pridoli) to Oriskany age, with the possibility that different areas of outcrop as well as different parts of the same area may be of widely different age within these limits.

Rocks of Probable Early Devonian Age

Beneath the well dated strata of Early Devonian age in the Moose River and Roach River synclinoria there are several units which regional considerations suggest are more likely of Early Devonian than Silurian age. A Silurian age cannot, however, be ruled out in either case due to the absence of diagnostic fossils.

WHISKY QUARTZITE

The term "Whisky Quartzite" is used as defined by Boucot (1961, p. 176).

Distribution

The Whisky Quartzite is known only on the northeast plunging southwest terminus of the Roach River synclinorium in the Moosehead Lake quadrangle.

Thickness

The Whisky Quarzite has a stratigraphic thickness of about 200 feet on Sugar and Deer Islands.

Description

The Whisky Quarzite is not topographically differentiated from the units which occur above and below. However, the shore of Deer Island between Whisky Island and Capens is largely determined by the strike of the Quartzite. The unit consists of white-weathering, massive exposures which have a rough surface due to the weathering and solution of the non-quartzose constituents, leaving the quartz grains in high relief. The quartz grains are chiefly granules, some fragments being as much as an inch in diameter, but the average diameter being about two millimeters, and are moderately well rounded. Much of the quartz is blue, and in this regard, is similar to that found in some of the graywacke of the nearby Cambrian or Ordovician rocks. Quartz grains comprise about eighty percent of the rock, the remainder being divided between grains of feldspar, felsite, slate, and fine-grained material. Pelmatozoan columnals are scattered through the rock, but constitute no more than one percent of the total volume. The beds vary in thickness from a few feet to twenty or more feet and are very well indurated. The rock has a light brown color when fresh.

The Whisky Quartzite contains no diagnostic fossils. On regional grounds it is concluded to overlie the Capens Formation with possible disconformity and to be conformable with the overlying Seboomook. Elsewhere in the region coarse clastic units and non-clastic units of Early Devonian age can be interpreted to grade up into the Seboomook. Such units include the Hobbstown Formation, Beck Pond Limestone, and Parker Bog Formation. All of these units are concluded to rest disconformably or unconformably upon pre-Devonian age rocks. With this information in mind the Whisky Quartzite is concluded to represent a restricted sheet of relatively coarse debris that was deposited adjacent to a local area of high relief (most likely to the northwest) near the onset of Seboomook time during the terminal portion of the Salinic interval (Salina through early Helderberg, Manlius-Coeymans time).

FRONTENAC FORMATION

The term Frontenac was first employed by McGerrigle (1935, p. 74-77) for volcanic and sedimentary rocks of pre-Compton (=pre-Seboomook) Formation age in Frontenac County, Quebec. Hurley and Thompson (1950, p. 838) suggested that the rocks exposed northwest of the outcrop belt of the Seboomook Formation in Somerset County are probably a part of the Frontenac Formation as used on the Canadian side of the international boundary. Albee (oral communication, 1959) also assigns these same rocks in Somerset County to the Frontenac Formation.

Distribution

The rocks of the Frontenac Formation occur in a northeast trending strip bounded on the northwest by the Seboomook Formation. To the southeast this strip is also bounded by the Seboomook Formation between Allagash Lake, Allagash Lake quadrangle (Plate 13) and Little Big Wood Pond, Attean quadrangle.

In the Attean and Long Pond quadrangles a strip about three to four miles wide, underlain chiefly by slate and phyllite, consisting of low irregular hills crossed by southeasterly flowing streams separates the area underlain by the topographically similar Seboomook Formation to the southeast from the rugged, northeast trending hills of the Boundary Mountains, underlain chiefly by massive sandstone, gabbro, and greenstone, to the northwest. The relief in the strip of low hills is usually no more than

a few hundred feet, but that in the Boundary Mountains is usually from 1,000 to about 1,500 feet.

Thickness

No published figures are available for the thickness of the Frontenac Formation in northern Maine. The breadth of outcrop and the variety of rock types exposed, suggest that the maximum thickness may be of the order of 10,000 feet. In the Allagash Lake area (Fig. 7) the rocks assigned to the Frontenac have a stratigraphic thickness of about 200 feet.

Description

A great variety of rock types occur in the Frontenac Formation of Somerset and Piscataquis Counties, Maine. The most frequent are gray to dark-green phyllite or slate and dark sandstone, which together constitute about 80 to 90 percent of the exposures studied. The remainder is largely made up of arkose and graywacke plus a minor amount of basalt and felsite.

The slate and phyllite are dark- to light-gray weathering rocks. Medium- to fine-grained dark sandstone is commonly interbedded with the slate and phyllite. The dark sandstone interbeds are usually from a few inches to a few feet in thickness. Many exposures of slate and phyllite show no variation in grain size or composition which can be used to determine the attitude of bedding, indicating that the beds may be 10 feet or more in thickness.

The cleavage planes glitter due to the development of micaceous minerals parallel to the cleavage surfaces.

The bedding in the dark sandstone may be distinct, usually with thin-bedded layers of subgraywacke separated by layers of finer grained material; or indistinct, usually in the more massive exposures lacking fine-grained material. Cross bedding is rarely observed, graded bedding is seldom a feature, and ripple marks are unusual by contrast with the Seboomook and Tarratine. The grain size varies from fine to medium and individual grains are angular; the bulk of the rock, from 50 to 80 percent, is made up of quartz grains. The remainder of the rock is composed of 5 to 10 percent detrital feldspar grains; the whole is surrounded by a groundmass of fine-grained dark material.

The graywacke is composed of a great variety of materials, including fragments of basalt, felsite, slate, quartzite, and granitic rock. The composition and grain size of the graywacke is very variable; some is made up largely of sand-size material, whereas some includes many pebbles. The grains, whether large or small, are usually angular to slightly rounded. The material between the fragments of rock is made up of angular quartz and feldspar fragments with quartz usually forming 40 to 90 percent of the total, plus a variable quantity of fine-grained dark material whose nature cannot be determined in the field. Some of the graywacke includes up to 20 percent of calcareous materials. The color of the graywacke is usually light gray or white on the weathered surface, probably due to alteration of the feldspar which is commonly abundant. Fresh surfaces of the graywackes are usually dark gray.

The basalt of the Frontenac Formation is dark green on the weathered surface. The rocks are a darker green in the fresh specimen than in the weathered specimen. Limonitic stains are found in the joints which cut the basalt. Pillow structure is present in some exposures of the basalt near Canada Falls Deadwater west of Seboomook Lake. Veinlets containing epidote and calcite commonly occur distributed throughout the basalt.

The felsite is white-weathering flinty rock. The color of the fresh felsite may be light or dark gray to black. Phenocrysts of quartz and feldspar are common in some of the felsite but absent in other parts.

Contacts

On the basis of reconnaissance mapping and the examination of a supposed contact in the Attean quadrangle, Boucot originally considered that the Frontenac Formation had been thrust over the Seboomook to the southeast. Albee and Boudette (oral communication, 1959) after more detailed mapping in the Attean quadrangle have concluded that the contact between the Frontenac and the Seboomook Formation is a normal one. Marleau (1958, p. 86-90) and Albee (oral communication, 1957) have concluded that the Frontenac overlies the Seboomook in the Attean quadrangle and areas of Quebec to the southwest as opposed to McGerrigle's (1935, p. 74-77) earlier opinion. Boucot's reconnaissance in the Allagash Lake region suggested to him that rocks present beneath the Seboomook Formation should be assigned to the Frontenac Formation (Fig. 7). It is obvious from the above comments that confusion reigns! Albee and Boudette (1965) have certainly invested more time mapping these rocks in a relatively limited area than anyone else, and their conclusions are in agreement with Marleau. However, Boucot cannot yet agree that the slate and phyllite to the north of his Seboomook boundary should be included with the Seboomoook as is done by Albee and Boudette.

Facies Relations

In the event that the conclusions of both Boucot and Albee are correct, the Frontenac in the Allagash Lake area would be a unit lying below the Seboomook Formation. This unit would then rise in the section to rest above the Seboomook in the Attean quadrangle. However, it is obvious that so many uncertainties still exist about the age and stratigraphic position of the Frontenac that it would be premature to accept any one set of conclusions.

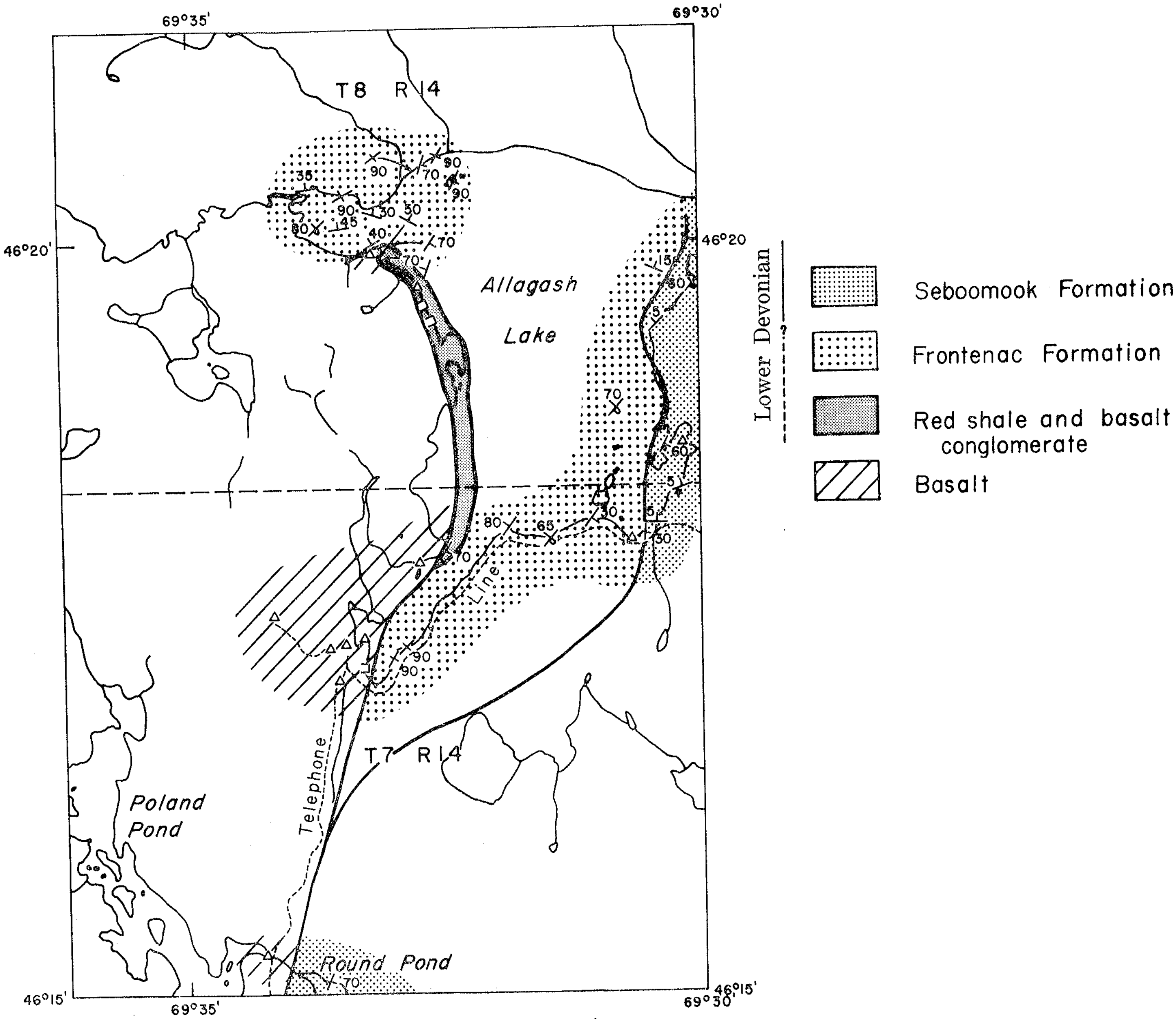

FIG. 7. Reconnaissance geology of the Allagash Lake region.

Age and Correlation

No fossils have been found in the Frontenac Formation of Quebec or northern Maine. If Boucot is correct in his interpretation of the relationships existing at Allagash Lake, the Frontenac Formation in that area would most likely be of Early Devonian and, or possibly Silurian age. If Albee is correct, the Frontenac would be expected to be entirely of Early Devonian, post-Seboomook age, and a probable equivalent of part of the Tarratine Formation.

Albee and Boudette (1965) have found exposures of fossiliferous Hardwood Mountain Formation to the northwest of those found by Boucot in this area. These exposures are interpreted by them to be overlain by Seboomook, which in turn is overlain to the northwest by Frontenac. These data offer very convincing reasons for concluding that the Frontenac is probably of Early Devonian age.

ROCKS OF SILURIAN AGE

Fossiliferous Silurian rocks are known in a number of discontinuous areas around the margins of the Moose River and Roach River synclinoria. The discontinuous nature of the Silurian rocks beneath the Devonian reflects the presence of a profound structural and stratigraphic discontinuity between the Silurian and Devonian of this region, which forms the basis for Boucot's Salinic disturbance (1962, p. 156).

Silurian strata of only Ludlow and Pridoli age occur northwest of the southeastern limits of the Moose River synclinorium, whereas Wenlock and Late Llandovery age strata occur further to the southeast. This relationship reflects the gradual northwesterly onlap which occurred in this region from the Early through the Late Silurian. This relationship is still maintained to the southwest in the Kennebago Lake and Cupsuptic quadrangles where Late Llandovery age fossils dated by Boucot have been recovered by Boudette and Harwood from the syncline in the southeasterly portion of those quadrangles and Pridoli age fossils from the northwest portion of the Cupsuptic quadrangle. The presence of Late Llandovery age fossils at Limestone Hill in the Stratton quadrangle southeast of the Moose River synclinorium is in agreement with this onlap concept.

Post (locality 1424) has recovered probable Wenlock age fossils from the southeast side of the Lobster Mountain Anticlinorium near the base of undifferentiated strata of Silurian age in The Forks quadrangle. This information also supports these conclusions.

UN-NAMED LIME-SILICATE HORNFELS OF LATE LLANDOVERY AGE

Pankiwskyj (1959) has described a sequence of Silurian hornfels on the slopes of Limestone Hill, Stratton quadrangle. Near the base of this sequence, where it is cut off by a conformable dioritic pluton, he made several fossil collections which were studied by Boucot. Wolfe has made collections in the same area. The detailed stratigraphy described by Pankiwskyj (1959) is unlike that uncovered to the southwest in rocks of similar age by Boudette and Harwood in the Kennebago Lake and Cupsuptic quadrangles, or to the northeast in work by Heath adjacent to the northeast end of the Roach River synclinorium. The absence of conglomerates on Limestone Hill is in strong contrast to the situation further southwest where conglomerate rich in quartz pebbles occurs. However, the presence of *Eocoelia* Community to the southwest as opposed to *Pentamerus* Community on Limestone Hill is consistent with this evidence; i.e., Limestone Hill bears a Community occurring seaward of that present to the southwest.

Pankiwskyj (1959) made three fossil collections containing the following forms.

Stratigraphically lowest occurrence: *Resserella* sp., *Pentamerus* cf. *P. oblongus*, *Leptaena "rhomboidalis,"* *Amphistrophia* cf. *funiculata*, *Eoplectodonta*? sp., *Howellella*? sp., *Atrypa "reticularis,"* rhynchonellid, *Merista*? sp., *Atrypina*? sp., tetracoral, *Favosites* sp., *Halysites* sp., *Heliolites* sp., *Cladopora* sp., pterineoid pelecypod, trilobite.

Stratigraphically median occurrence: *"Dolerorthis"* cf. *"D." flabellites*, *Resserella* sp., *Pentamerus* cf. *P. oblongus*, *Leptaena "rhomboidalis,"* *Amphistrophia* cf. *A. funiculata*, *Plectatrypa* cf. *P. imbricata*, *Atrypa "reticularis,"* *Coolinia* sp., *Dicaelosia* sp., *Dictyonella* sp., *Favosites* sp., *Halysites* sp., *Heliolites* sp., *Euomphalus* sp.

Stratigraphically highest occurrence: *Pentamerus* cf. *P. oblongus*, *Amphistrophia* cf. *A. funiculata*, *Eospirifer* sp., *Euomphalus* sp.

The above three collections suggest an age span in the range of C_3 - C_6 of the Upper Llandovery. The *Dicaelosia* is a form which is suggestive of the upper rather than the middle portion of the Upper Llandovery. An Early Wenlock age cannot, however, be completely ruled out for this collection. A boulder collected by Pankiwskyj (1959) at Morgan's Camp on the southwest shore of Spring Lake contained *Goniophyllum* sp., *Oriostoma* sp., plectambonitid, *Euomphalus* sp., and *Howellella*? sp. The rock is similar to that found on Limestone Hill and represents the first northern Appalachian occurrence of *Goniophyllum* (the specimen was forwarded to W. A. Oliver, Jr., U. S. Geological Survey for study after preliminary identification by Boucot).

Material collected by Dr. C. W. Wolfe on Limestone Hill contained the following gastropods described by Boucot and Yochelson, (1966, locality 3745): *Euomphalopterus* sp., *Oriostoma* sp., and *Poleumita* sp. The occurrence of these shells is consistent stratigraphically with those obtained by Pankiwskyj.

LOBSTER LAKE FORMATION
(Pl. 8, Figs. 1-3)

The term Lobster Lake Formation, including the main part of the Formation and its Big Claw Red-Bed Member is used as defined by Boucot (1961, p. 178-180).

Distribution

The Lobster Lake Formation is present on the northeast plunging nose of the Lobster Lake Anticline from a point roughly two miles southwest of Jackson Cove, Northeast Carry quadrangle, to a point opposite Kidney Pond, Ragged Lake quadrangle.

Beds similar in appearance to those of the Big Claw Red-Bed Member occur on the southeast side of Caucomgomac Lake, Caucomgomac quadrangle, and underlie limestone conglomerate on the outlet a short distance south of the dam, similar in appearance to that of the Lobster Lake Formation.

Thickness

The maximum thickness of the Lobster Lake Formation is present on the northeast plunging nose of the Lobster Mountain Anticline where about 4,000 feet of beds are present. The Big Claw Red-Bed Member has a thickness of about 250 feet.

MAIN PART OF THE LOBSTER LAKE FORMATION

Description

The main part of the Lobster Lake Formation includes limestone, limestone conglomerate, calcareous sandstone, calcareous siltstone, calcareous slate, and quartzitic sandstone. Some of the more massive, 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 vary in many respects between exposures, and can seldom be traced for any distance. Some of the purer limestones are very fine-grained, light-gray to blue-gray, unbedded, conchoidally fracturing, and gray-weathering. As the percentage of argillaceous material increases, the limestones become darker. One of these argillaceous limestones upon acid solution was found to contain 47 percent argillaceous material, largely clay sized. Some of the argillaceous limestones are fossiliferous, containing crinoidal debris, and some are fine-grained and very homogeneous. The more argillaceous limestones weather to a buff-brown, punky rind. Many of these are interbedded with calcareous slate, and on weathering, the limestones dissolve more rapidly, resulting in a ribbed weathering surface. A typical outcrop is composed of thin beds (2 to 4 inches thick), the shales standing out in strong relief relative to the limestone. These limestone beds in turn are typically pitted, each pit being concave and roughly ellipsoidal in form. The resulting "pitrock" is common in the Formation. One such limestone collected North of Cranberry Pond, North East Carry quadrangle, contains many very small pyrite crystals.

The limestone conglomerates are likewise 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, pure limestone to dark-gray, fossiliferous, argillaceous limestone. The conglomerates are normally situated in low ledges and occur as massive, unbedded units.

Calcareous sandstones have been observed in a few places in this Formation. They normally contain moderately sorted and rounded quartz grains, a high percentage of feldspar, some brown clay matrix, and calcite cement. Those sandstones, which occur as massive, unbedded outcrops, are gray.

Siltstone and slate of the Lobster Lake Formation make up 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. Dark slate, light-gray siltstone and slate, and green slate are present. These are invariably cleaved, the thickness and smoothness of the resulting planes being a function of the grain size and mineralogy. 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 weather light-brown.

Some quartzitic sandstone is found within the main part of the Lobster Lake Formation, though more abundant in the Big Claw Red-Bed Member. These rocks are normally buff, non-porous, well cemented with silica, moderately well 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 2 to 3 feet thick.

Contacts

The similarity between the dark-gray slates of this Formation and those of the overlying Seboomook makes a determination of the contact between the two difficult. The 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.

The Lobster Lake Formation is concluded to rest disconformably beneath the Seboomook because of their map relations. The Lobster Lake reaches a maximum thickness of about 4,000 feet on the northeast plunging nose of the Lobster Mountain Anticline. This thickness diminishes to a feather edge southwesterly, on both flanks of the anticline, within

a few miles. The best explanation for the rapid disappearance of a largely marine unit like the Lobster Lake is the presence of an interval of erosion between it and the overlying strata.

Facies Relations

As presently understood the main part of the Lobster Lake Formation consists of a complex series of interbedded calcareous and argillaceous rocks with a few minor arenaceous beds as well. The detailed relationships of these rocks are not understood because of lack of exposure.

Age and Correlation

Stumm (1962, p. 2, 3, 4, 6) reports the presence of *Streptelasma*? sp. *C*, *Cystiphyllum* sp. *A*, *Tryplasma nordica*, and *Cystihalysites* cf. *C. amplitubulata*, at locality SD-3400 where *Leptaena "rhomboidalis"* was also obtained. Oliver (1962, p. 11) considers that the corals of the Lobster Lake Formation are similar to those of the Hardwood Mountain and Mont Wissick Formations of Ludlow and Pridoli age. On the southwest shore of Lobster Lake poorly preserved specimens of *Kirkidium* cf. *K. knighti* were observed but not collected. In addition, loose blocks of argillaceous limestone containing a *Gypidula* similar to the one present in the Hardwood Mountain Formation were collected on the shore of Lobster Lake (USNM loc. 12113). All of the above data indicate that the main part of the Lobster Lake Formation is of Ludlow-Pridoli age, correlative with the Hardwood Mountain Formation. It is possible that in pre-Oriskany - Late Helderberg time there was a continuous layer of strata deposited over an area from the Hardwood Mountain locality to the Lobster Lake region. This condition would have been prior to erosion during the Salinic disturbance.

BIG CLAW RED-BED MEMBER

Description

This member includes interbedded conglomerates, argillaceous and orthoquartzitic sandstones, siltstone, and shale. It is readily distinguished from surrounding Formations by its vivid red, brown, and maroon colors.

The basal bed of the Big Claw Red-Bed 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 clay matrix which includes numerous smaller grains of the pebble equivalents. Many of the clasts 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.

On Lobster Lake the basal conglomerate is overlain by a section of interbedded sandstone, siltstone, and shale comprising a thickness of 175 feet. The siltstone and shale 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 grains. A few grains of relatively fresh plagioclase were observed in section. The matrix of the siltstone and shale consists of red, hematite-stained argillaceous material.

The quartzitic sandstone beds associated with the siltstone 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 conglomerate 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 quartz. These sandstones form pronounced ledges.

Within the Big Spencer Mountain and Blood Pond area large blocks of vividly colored siltstone have been widely distributed by glacial activity. These blocks have a yellowish color mottled with dark maroon to give a leopard skin effect. This unusual rock type has been observed in place on the west shore of Kidney Pond interbedded with greenish and pinkish orthoquartzitic sandstone that occurs in three to five foot thick beds. These sandstones are dense, impervious, fine grained, and white weathering.

Overlying the zone of sandstone and siltstone at Lobster Lake is about 75 feet of thin-bedded, brightly colored sandy shale and argillaceous sandstone. Colors in this zone include red, pink, and yellow, and the uppermost bed is grayish green. These beds are moderately to poorly indurated, and they contain a large amount of argillaceous material, and a noticeable percentage of black organic matter.

In summary the Big Claw Red-Bed Member contains three zones: a basal conglomerate a few inches to one foot thick, 150 feet of overlying interbedded quartzose mudstone and siltstone, and, at the top, 75 feet of shale and argillaceous sandstone. The total section contains about 60 percent quartzose sandstone and conglomerate, 30 percent siltstone and argillaceous sandstone, and 10 percent shale.

Contacts

The upper contact of this Member is not actually exposed but the evidence on either side of the contact area suggests that it is gradational rather than abrupt. The lower contact is well exposed on the east shore of Lobster Lake where it rests with angular unconformity upon Cambrian or Ordovician rocks. At the actual contact, which has a relief of several inches in the outcrop studied, granules made

up of about 20 percent phyllite, 30 percent light-colored felsite, 50 percent milky quartz, plus fine-grained micaceous groundmass rest upon the reddish phyllites and are in turn overlain by red sandstone of the Big Claw. The steeply dipping cleavage of the underlying reddish phyllite is abruptly truncated by the bedding of the overlying Big Claw Red-Bed Member. Elsewhere this contact has not been observed.

Facies Relations

Facies relationships within this Member doubtless exist but the presently available data are inadequate to produce any conclusions.

Age and Correlation

The Big Claw Red-Bed Member has not yet yielded fossils. Its stratigraphic and regional position suggest that it is best assigned to the Ludlow rather than the pre-Ludlow. Regional distribution of Silurian rocks indicates that southeast of a line on the southeast side of the Moose River synclinorium pre-Ludlow age marine rocks are present, whereas to the northwest of this line they are absent. The Lobster Lake Formation is close to the line, but fits best on the northwest side. The rocks present in the pre-Ludlow age Silurian strata to the southeast of the Lobster Lake area are different enough in appearance and sequence to preclude placing the Big Claw with them.

HARDWOOD MOUNTAIN FORMATION (Pl. 9, Figs. 1-2)

The term Hardwood Mountain Formation is used here as defined by Boucot (1961, p. 180-182). More detailed mapping by Griffin, Baker, and Waite (in preparation) will produce a reasonable type section from the type area of the Formation.

Distribution

Exposures of the Hardwood Mountain Formation are known in the outlier northwest of Spencer, and King and Bartlett Mountains, Spencer quadrangle; in Jim Pond, Flagstaff and T4 R5 Townships, Spencer and Chain Lakes quadrangles; and in the Little Big Wood Pond area, Dennistown Township, Attean quadrangle. Albee and Boudette (1965) have shown an area of rocks assigned to the Silurian on the east slope of Sally Mountain. Boucot reinterprets the conglomeratic portion of this area as belonging to the Hobbstown Formation, and the fine-grained, fossiliferous portion to the Hardwood Mountain Formation. Outcrops on Sally Mountain are scattered so that the relationships between these two rock types have not been observed.

Thickness

The thickness, as determined from cross-section, is from a feather edge to about 3,000 feet. Interruption of the section southwest of Hardwood Mountain by faulting produces the uncertainty regarding maximum thickness. In the area of Little Big Wood Pond the maximum thickness is about 200 feet, but this low figure is probably due to removal of the Formation by erosion that preceded the deposition of the disconformably overlying Seboomook Formation. Thickness estimates for the Jim Pond area are unreliable, due to the complexities of the structure, but it is probable that they extend from a feather edge to about 1,000 feet, although here again, the maximum thickness may have been greatly reduced by erosion prior to the deposition of the overlying Seboomook Formation. The incorporation in the Hobbstown Formation of rocks similar to those found in the Hardwood Mountain Formation, plus the disconformable relation of the overlying Hobbstown Formation northwest of Spencer Mountain indicates that the original maximum thickness of the Hardwood Mountain Formation is not preserved there. It is probable that the original, maximum thickness of the Formation is no longer preserved anywhere in Somerset County.

Description

The Hardwood Mountain Formation is a heterogeneous assemblage of fine- to medium-grained quartz- and feldspar-rich calcareous clastic rocks, with some impure limestone. The most abundant rocks are calcareous mudstone and siltstone; coarser rocks are less common but include a striking limestone conglomerate made up of pebbles of limestone in a matrix of calcareous siltstone or mudstone. In the type area calcareous siltstone and mudstone form 60 percent of the unit, limestone conglomerate 10 percent, calcareous slate 20 percent, limestone 5 percent, and medium-grained sandstone 5 percent.

The calcareous siltstone and mudstone is blue-gray but weathers dark brown; it forms massive 2 to 5-foot beds with little cleavage. Successive layers contain variable amounts of calcareous material which weathers to different depths, giving some exposures a ribbed appearance. The siltstone and mudstone are fine to medium grained and contain 10 to 50 percent poorly rounded or angular grains of quartz with a little feldspar and 10 to 20 percent pelmatozoan fragments in a matrix of fine-grained dark silt. They contain lenses of quartz, feldspar, and limestone pebbles.

The limestone conglomerate is prominently exposed but constitutes only about 10 percent of the unit. It forms massive outcrops in which bedding is very obscure. On weathering, the limestone pebbles dissolve and leave pits as much as an inch deep and an inch to several inches across. The matrix is fine- to medium-grained calcareous siltstone and weathers buff colored. Proportions of pebbles and matrix are highly variable. In places the pebble beds grade laterally into limestone from which they were derived.

The limestone beds of the Hardwood Mountain Formation are massive and irregular and are largely stromatoporoidal debris interspersed with tetracorals. Irregular layers and stringers of noncalcareous debris and slate occur throughout.

The sandstone of the Formation consists largely of angular quartz grains, with 5 to 15 percent feldspar and small pebbles of granitic rocks from the basement complex. Variable amounts of calcareous matrix are present. Weathered surfaces are light brown and porous.

Facies Relations

The lower portion of the Hardwood Mountain Formation, from southwest of Baker Pond to Jim Pond, consists of about fifty feet, of very punky weathering, calcareous, light-colored siltstone overlain by limestone conglomerate and limestone. These lower siltstones have not been observed in the area southwest of Hardwood Mountain in Hobbstown Township or in Dennistown, where the lower portion of the Formation consists of coarse-grained calcareous, arkosic sandstone. The remainder of the Formation consists of a seemingly heterogeneous association of calcareous siltstone, mudstone, limestone, limestone conglomerate, and slate. The presence of coarse, basal clastic debris in the Hardwood Mountain Formation of the Hardwood Mountain and adjacent Dennistown areas suggests that a local source of coarse, granitic, basement complex debris was available, whereas to the southwest, between Baker Pond and Jim Pond such was not the case.

Contacts

The upper contact of the Hardwood Mountain Formation with the Hobbstown Formation in Hobbstown Township is a disconformity. The actual contact was cleaned off at fossil locality SD-3479, Hobbstown Township. At this locality gray slate, containing a few thin layers of coarse, clastic debris, and having fossils scattered throughout, of the Hardwood Mountain Formation is overlain by the Lower Conglomerate Member of the Hobbstown Formation. The contact is very sharp with no evidence of gradation or of any structural disturbance, the beds on both sides of the contact being parallel. The lower four inches of the Hobbstown Formation at this locality consist of coarse-grained granitic debris together with a large amount of shell debris and fine-grained dark, argillaceous material. The evidence at this locality suggests that there was an abrupt change from the deposition of fine-grained material to that of coarse, granitic and rhyolitic debris including boulders up to several feet in diameter. To the southwest, in Jim Pond Township the actual contact between the Hardwood Mountain Formation and the overlying Hobbstown or Seboomook Formations is not exposed. However, the field evidence points to the pinching out of the Hardwood Mountain Formation northeastward, probably due to erosion occurring prior to the deposition of both the Hobbstown and Seboomook Formations. About two hundred yards northeast of Fox's Camp on Little Big Wood Pond the contact of the Hardwood Mountain Formation with the overlying Seboomook Formation was excavated. The observed relationship at that locality was a very sharp contact between dark-gray, impure limestone of the Hardwood Mountain Formation and the overlying gray slate of the Seboomook Formation. The overlying Seboomook Formation included pebbles, up to three inches in diameter, of limestone resembling that in the underlying Hardwood Mountain Formation plus a few pebbles of gray granite resembling that of the nearby basement complex.

On the northwest side of Spencer Mountain the Hardwood Mountain Formation has been inferred to rest with angular unconformity beneath the Hobbstown Formation.

It is concluded that the upper contact of the Hardwood Mountain Formation is a marked unconformity, which has been proved to be present southwest of Hardwood Mountain under the Hobbstown Formation, north of Fox's Camps under the Seboomook Formation, and inferred to exist in Jim Pond township beneath the Seboomook Formation and on Spencer Mountain beneath the Hobbstown Formation.

Griffin, Baker, and Waite (in preparation) have observed the basal contact of the Hardwood Mountain Formation on the slopes of Hardwood Mountain. At a well exposed outcrop conglomerate rich in basement complex clasts rests upon the basement complex and is itself gradationally overlain by typical strata of the Hardwood Mountain Formation.

Age and Correlation

The age and correlation of the Hardwood Mountain Formation poses several trying problems. The distribution of the fauna (Table 8) is very erratic, with large faunules being present at some localities, SD-3488 for example, which are very unlike those present at others, SD-3469 for example. This seemingly erratic distribution is ascribed to the presence of a variety of faunal facies. Due to the absence of continuous exposures this idea cannot be proved.

The brachiopods of the Hardwood Mountain Formation collected during the course of Boucot's work do not demonstrate anything more than a C_3 to Ludlow or Pridoli age span. Subsequently Albee found exposures of the Hardwood Mountain Formation in the Attean quadrangle which contained *Eccentricosta*, a shell restricted in the central Appalachians to strata of Pridoli age. Klapper (written communication 1968) has recognized conodonts of latest Ludlow through Pridoli age (*Spathognathodus primus* and *S. canadensis*) from limestone on the north shore of Little Big Wood Pond. His report is as follows:

Fox's Camp — Little Big Wood Pond
Attean quadrangle, Somerset Co., Maine

7900 grams processed

Spathognathodus remscheidensis Ziegler
S. primus (Branson and Mehl)
Ozarkodina denckmanni Ziegler
Ozarkodina sp.
Lonchodina greilingi Walliser

Spathognathodus of the *S. remscheidensis* type range from the higher part of the Ludlow (highest Kopanina) at least to the top of the Gedinnian. True representatives of *S. primus* have not been observed higher than the Pridoli. On the basis of conodonts, therefore, the sample may be assigned a position in the interval from the highest part of the Ludlow through the Pridoli.

Berdan (written communication, 1956) considers that the presence of *Dibolbina, Limbinaria,* and *Dizygopleura* cf. *D. costata* characteristic of the Tonoloway Limestone of Pridoli age, and of *Mirochilina* known elsewhere in beds of Ludlow or Pridoli age, all indicate a Late Silurian age for the unit.

Whittington and Campbell (1967) consider that the silicified trilobites from SD-3488 are of Early Ludlow or Late Wenlock age. This locality, however, contains a fauna almost completely different from those present elsewhere in the Hardwood Mountain and might represent a slightly different, older horizon, near the base of the Formation at this one spot.

Stumm (1962, p. 2-6) has studied corals from the Hardwood Mountain Formation. Oliver (1962, p. 11) has concluded that the Hardwood Mountain, Lobster Lake, and Mont Wissick are all of about the same age because of the similarity of their coral fauna. The Mont Wissick contains *Kirkidium* cf. *K. knighti* which indicates a Ludlow age.

All of this evidence considered together indicates that the Hardwood Mountain Formation is of Ludlow and Pridoli age, except for the possibility that the exposure represented by SD-3488 might be of Late Wenlock age.

Alternatively it might be considered that the Hardwood Mountain Formation of the Spencer Mountain and Big Jim Pond areas is of Ludlow and possible Late Wenlock age, whereas the *Eccentricosta*-bearing Hardwood Mountain Formation containing identified conodonts, of the Attean quadrangle, is of latest Ludlow and Pridoli age only.

UNDIFFERENTIATED STRATA OF SILURIAN AGE
(Pl. 12, Fig. 2)

Beneath the Parker Bog, Capens, Seboomook and the Tarratine Formations are unnamed calcareous slate, phyllite, sandstone, quartzite, limestone conglomerate, and conglomerate whose precise age and relations are unknown. These rocks may be geographically divided into two groups. The first is present on the southeast limb of the Moose River synclinorium and the southwest end of the Roach River synclinorium, and has not yielded zonable Silurian fossils. Its relations with the overlying Seboomook on the southeast side of the Moose River synclinorium do not preclude the possibility that part of the unit may be of Early Devonian age. The second is present on the southeast and northeast sides of the Roach River synclinorium, as well as on both sides of the Caribou Lake anticline and adjacent areas to the east. This second group has yielded zonable Silurian fossils at a number of localities but its detailed stratigraphy is not yet well enough understood to justify the setting up of a formal nomenclature. The terms Ripogenus Series (Toppan, 1932, p. 71) and Chesuncook Limestone (Willard, 1945) have been used for rocks belonging to this second group, but the available information on these rocks does not lend itself satisfactorily to their meaningful use at this time.

Thickness

The width of outcrop and attitude of these rocks on the southeast side of the Moose River synclinorium and at the southwest end of the Roach River synclinorium indicates that a thickness of at least 2,000 feet is reasonable and 6,000 feet is possible in view of the presence of highly stretched and flattened pebbles in some of the limestone conglomerates. On the southeast and northeast sides of the Roach River synclinorium similar figures can be obtained. From cross-sections thicknesses of 1,600 feet are estimated for the Siras Hill area and 4,200 feet for the area between Ragged and Caribou Lakes. Further east, in the Harrington Lake quadrangle, thicknesses of 425 to 960 feet are estimated from available cross-sections. This last information has been calculated from data provided by Griscom.

Description

On the southeast side of the Moose River synclinorium and at the southwest end of the Roach River synclinorium the most abundant rocks are calcareous phyllite and slate which weather brown with a punky rind but are blue gray to dark gray where fresh. The calcareous material is almost entirely pelmatozoan columnals and other shell debris, segregated into lenses that grade laterally into slate or phyllite.

Calcareous sandstone and limestone conglomerate make up about 15 to 20 percent of the exposures. The sandstone contains much fine-grained poorly sorted angular to poorly rounded quartz grains and some shell debris, and has a punky rind.

The limestone pebbles of the limestone conglomerate weather more readily than the slate or phyllite matrix, producing a pitted appearance.

The undifferentiated strata of Silurian age on the southeast and northeast sides of the Roach River synclinorium, as well as adjacent to the Caribou Lake anticline and the Ripogenus Dam area, may be categorized as follows: They consist of a basal conglomerate and quartzite, interbedded limestone and calcareous shale which at two localities include red and green slate, white orthoquartzitic sandstone, and interbedded carbonate-rich shale and argillaceous sandstone. The white orthoquartzitic sandstone separates them readily into an upper and lower calcareous section.

The basal conglomerate has been observed at four localities: Ripogenus Dam, Deer Pond, the south shore of Caribou Lake, and a small knoll one mile south-southeast from the Ragged Stream outlet on Caribou Lake. Though these outcrops display minor differences, the similarities in texture and bedding thickness indicate that they all belong to one unit. 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 feldspar, some specular hematite, and a large amount of iron stained clay matrix. 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 small amount of carbonate. Feldspar content is as high as 25 percent making this basal unit an arkosic conglomerate. At Ripogenus Dam the conglomerate grades upwards into a quartzite.

Directly overlying the conglomerate is a calcareous unit (interbedded limestone and calcareous shale) of 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 slate. Though not observed, these slates may well occur at Deer Pond also. At Ripogenus Dam they are absent. Similiar slate has been noted by Griscom (in preparation) on the north shore of Ripogenus Lake about one mile northwest of the dam. The limestone is dark gray, very argillaceous, fossiliferous, and weathers to a soft, buff, punky residue. In many places it is interbedded with more resistant calcareous slate, the slate occurring as thin ridges in relief above the limestone. The surface of the limestone 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 calcareous 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 (in preparation). It is a massive, tough, silica-cemented, well sorted, fine-grained, unusually clean orthoquartzite. Individual grains are subrounded, and have a few 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 beds overlying the orthoquartzitic sandstone consist of a variety of lithologies. These include calcareous sandstone, slate, and siltstone, plus argillaceous limestone and some non-calcareous red slate.

Calcareous sandstone is abundant in the area east of Ragged Lake. It is normally found in massive beds ranging up to several feet in thickness. Fresh surfaces of the rock have a distinct pink tinge, but weather buff. This is a 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 visible, but banding is distinct on weathered surfaces.

A few gray, thinly laminated, tough, calcareous, well-cemented siltstones were noted within these upper calcareous beds. In an area about 0.8 miles 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, calcareous siltstone which weather brown.

Slate occurring in this upper calcareous unit is dark gray to gray green, calcareous, soft, normally cleaved, and light brown weathering. The gray slates are normally interbedded with argillaceous limestone. The dark red, fine-grained, cleaved, slightly micaceous, non-calcareous slate exposed on Siras Hill may belong to the Capens Formation rather than this unit.

Limestone occurring in this upper calcareous unit is characteristically dark-gray, very argillaceous, fossiliferous, and soft, buff, weathering to a punky residue. These limestones are commonly interbedded with more resistant calcareous slate, which differentially weathers to give a pitted effect. With the exception of one thin, 6 foot bed of pure, massive, blue-gray limestone lying below the white orthoquartzitic sandstone and situated on the south shore of Caribou Lake, pure limestone is noticeably absent from the Silurian of this region.

Contacts

The upper contact of these rocks on the southeast side of the Moose River synclinorium has been seen only in the valley of Cold Stream (Pierce Pond quadrangle) where it is sharply separated by a minor fault or displacement from the Seboomook Formation. Elsewhere the contact with the overlying Seboomook, Parker Bog, and Tarratine Formations is inferred on regional grounds to be disconformable. The unit is absent southwest of

Parker Pond, Spencer quadrangle, due to faulting. It is absent beneath the Tarratine Formation on the east side of Moosehead Lake, presumably due to removal prior to the deposition of the Tarratine Formation.

At the southwest end of the Roach River synclinorium this unit is interpreted to be gradationally overlain by the Capens Formation on Deer and Sugar Islands. On the southeast side of this synclinorium, on Siras Hill, a similar relationship exists.

The lower contact has 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 Silurian unconformably overlies pre-Silurian basalt. At Caribou Lake, the basal conglomerate overlies with angular unconformity beds of Cambrian or Ordovician age, but minor displacements obscure this relationship to a certain degree.

Facies Relations

Not enough is known about this unit to make a statement about facies relations very meaningful. However, the white, quartzitic sandstone found near the base of the undifferentiated strata of Silurian age in the area of Ripogenus Dam and the Caribou Lake anticline may possibly be a lateral equivalent of some of the calcareous rocks present in scattered areas where the quartzitic sandstone is apparently not present.

Age and Correlation

No diagnostic fossils have been found in the belt of undifferentiated strata of Silurian age on the southeast side of the Moose River synclinorium. The same is true of the similar beds at the southwest end of the Roach River synclinorium, where *Atrypa "reticularis"* has been found at SD-3150 indicating a C_3 through Early Devonian age limit. However, the general similarity of these beds to well dated Silurian strata elsewhere in northern Maine makes a Silurian assignment necessary with the the proviso that Early Devonian beds could be expected to occur in limited areas near the top of the unit.

Post has mapped (Boucot, *et al.*, 1964) the logical continuation of this unit in The Forks quadrangle on the southeast side of the Lobster Mountain Anticlinorium. At his locality 1424 Boucot has identified *Leangella* sp. and a possible *Amphistrophia* cf. *A. funiculata* which suggests a Wenlock age. This locality is near the base of the unit at a spot a short distance to the west of Cold Stream. Post's data support a Silurian age for at least a portion of these beds occurring at the southwest end of the Roach River synclinorium.

On the northeast and southeast sides of the Roach River synclinorium as well as on both sides of the Caribou Like anticline and adjacent areas near Ripogenus Dam zonable fossils have been found in some abundance. The presence of *Leangella*, a genus not known above the Wenlock, in association with an eospiriferid (*Cyrtia*? sp.), a delthyrid (*Howellella*? sp.), *Atrypa "reticularis," Atrypina* sp., and *Meristina* sp. which indicates a C_3 or later age at U.S.N.M. Locality No. 12119 (collected by G. Espenshade, 1964, N. of Farrar Mountain, First Roach Pond quadrangle) provide a C_3 to Wenlock bracket. A few fragmentary specimens of *Dicaelosia* sp. from this locality appear to belong to a species more like those to be expected in the Late Llandovery C_3-C_5 interval than in the C_6 and later interval. The presence at SD-2887 (Hurley and Thompson's 1948 locality 86, Kokadjo-Ripogenus Road, 0.5 NE of Bear Brook) of a poleumitid gastropod, a pentamerinid brachiopod and *Atrypa "reticularis"* indicates the presence of C_3 to Ludlow age beds. Locality SD-2887 was not recovered by Heath during his reconnaissance but does fit into Heath's mapping satisfactorily.

There are a number of localities on both limbs of the Caribou Lake anticline from which Erinakes (in preparation) has found *Pentamerus oblongus* suggesting a C_3-C_5 age. In addition both Boucot in 1953 and Erinakes in company with Boucot in 1964 have found abundant *Rhipidium multicostellum* on Steamboat Rock in Chesuncook Lake indicating a Late Wenlock age. On the west shore of Chesuncook Lake south of Quaker Brook, Erinakes found a locality which has yielded brachiopods of possible Ludlow age.

Summation of this information indicates the presence in the area of *Pentamerus*-bearing C_3-C_5 age beds, *Rhipidium*-bearing Late Wenlock age beds, and shell beds of possible Ludlow age. Additional collecting and mapping could well result in a detailed stratigraphy and faunal sequence in this region. It is of interest to point out that *Pentamerus oblongus* occurs both above and below the white quartzitic sandstone.

CAPENS FORMATION

The term Capens Formation is used here as defined by Boucot (1961, p. 177).

Distribution

Rocks assigned to the Capens Formation have been recognized on Deer and Sugar Islands in Moosehead Lake. They are also present in roadcuts between Burnham Pond and the East Outlet of the Kennebec River, Big Squaw Township, Moosehead Lake quadrangle. The red slate exposed on the east slope of Siras Hill, Roach River quadrangle probably belongs to the Capens Formation. The red slate present in some abundance on the shore of Frost Pond, Harrington Lake quadrangle may also belong to the Capens but the stratigraphy of that area is too poorly known to provide a sound basis for such a conclusion at the present time.

Thickness

The thickness of the Capens Formation is from 200 to 400 feet on the east side of Deer Island. The thickness on Siras Hill is comparable.

Description

Fine-grained and well-indurated red and green slates make up 90 percent of the outcrops and are either interbedded in layers a few inches to several feet thick or as units 10 to 20 feet thick.

Interbedded with the red or green slate is conglomerate, which consists of moderately well rounded pebbles in a matrix of angular to moderately well rounded quartz sand and fine-grained dark limestone, and slate. The felsite pebbles resemble the Lobster Mountain Volcanics, the Kennebec Formation, and the volcanics of the undifferentiated Cambrian or Ordovician.

Contacts

The upper contact with the overlying Whisky Quartzite is sharp on the east side of Deer Island. The significance of this relation is not clear owing to the uncertainty about the precise age of both units. It is concluded from regional considerations that this contact is an important disconformity reflecting the Salinic Disturbance.

Facies Relations

Insufficient data are available to make useful conclusions as to facies relations within the Capens Formation.

Age and Correlation

Fossils have not been found in the Capens Formation. The unit is assigned to the Silurian because of inferences made from the stratigraphy of the region and the presence of a Salinic Disturbance.

FOSSILIFEROUS ROCKS OF ORDOVICIAN AGE

KENNEBEC FORMATION

The term Kennebec Formation is used here as defined by Boucot (1961, p. 183).

The Lobster Mountain Volcanics contain a variety of light- and dark-colored volcanic rocks. It is possible that the Kennebec Formation will be found upon further study to be merely a very local development of the Lobster Mountain Volcanics. However, because of the regional significance of the well dated Middle Ordovician fossils in the Kennebec it is felt unwise to join it at this time with the more widely distributed, poorly dated Lobster Mountain.

Distribution

The rocks assigned to the Kennebec Formation crop out between Cornish Farm and Long Pond (Taunton and Raynham, Misery Gore and Sapling Townships), Brassua Lake quadrangle. Rocks of similar lithology and age have not been recognized elsewhere in northern Maine.

Thickness

The thickness of the Kennebec Formation is unknown but is probably a few hundred to a thousand feet.

Description

Fresh surfaces of the rhyolite tuff and felsite are olive drab, and weathered surfaces and rind are white. The felsite is flinty, with a conchoidal fracture, and the more massive parts contain pyrite. Both the tuff and massive felsite contain abundant quartz phenocrysts. The tuff is poorly sorted and consists of irregular fragments of felsite, quartz phenocrysts, and much silt. The fine-grained layers are metamorphosed to phyllite whose cleavage planes are coated with platy minerals.

Rapid analysis of fossiliferous rhyolite tuff from fossil locality SD-2742 near Somerset Junction (Plate 30)

	Percent
SiO_2	68.4
Al_2O_3	17.0
Total Fe as Fe_2O_3	3.4
MgO	1.4
CaO	0.35
Na_2O	2.4
K_2O	4.3
TiO_2	0.56
P_2O_5	0.14
MnO	0.01
Ignition*	2.6
Sum	101.
FeO	2.1
Fe_2O	1.1

* includes gain due to oxidation of FeO

Analysts: E. A. Nygaard
H. F. Phillips
C. F. Ferreira

(Report No. IWC-324, Lab. No. 52-474-CWP).

Contacts

The contact relations of the Kennebec Formation are unknown. It is presumably in either fault contact or unconformably below the beds on the northwest side of the lineament marking the southeast limit of the Moose River synclinorium.

Facies Relationships

The Kennebec Formation near Somerset Junction consists chiefly of coarse to medium-grained tuff, while to the southwest on the knob just north of Cornish Farm the rocks consist of massive felsite.

Age and Correlation

The Kennebec Formation is of Early to Middle Middle Ordovician age as evidenced by the fauna listed below from locality SD-2742:

Orthambonites? sp.
Valcourea sp.
Sowerbyites? sp.
Loxoplocus (*Lophospira*) sp.
Mastopora sp.
Isotelus? sp.

Fossils have not been found elsewhere in the unit except for a single pelmatozoan columnal at locality SD-2876.

UNFOSSILIFEROUS ROCKS OF PRE-SILURIAN AGE

Associated with both the Moose River and Roach River synclinoria are a variety of unfossiliferous pre-Silurian age rocks. These rocks were not given detailed treatment during the course of this investigation. For convenience they may be divided into three general categories:

1. Basement complex, chiefly granitic and gneissic, occurring between the two southwestern prongs of the Moose River synclinorium.
2. Areas of volcanic rocks, both light and dark, present in the Lobster Mountains and three localities on the northwest limb of the Moose River synclinorium's southeast prong.
3. A very heterogeneous assemblage of slate, phyllite, graywacke, dark sandstone, light and dark volcanic rocks, and carbonate rocks occurring on the southeast side of the Moose River synclinorium and around the northwest, northeast, and southeast sides of the Roach River synclinorium.

BASEMENT COMPLEX
(Pl. 11, Fig. 2)

In western Somerset and northern Franklin Counties the oldest rocks are a pre-Ludlow and probably pre-Late Llandovery age basement complex consisting predominantly of regionally metamorphosed granitic and gneissic rocks, which were not studied in detail. There are also many bodies of amphibolite in the area. Woodard (1951, p. 76) termed the amphibolite on Spencer Mountain, Spencer quadrangle, *the Spencer Mountain basics*; but in this paper the amphibolite is included in the basement complex, to which no formation name is given. Marleau (1958) termed the gneissic rocks the Arnold River Formation. The distribution of the gneissic and granitic rocks of the basement complex is outlined in Boucot, *et al.* (1964).

On the geologic maps of this region the granitic basement complex has been differentiated as an intrusive unit, *gd*, of Ordovician (?) age, whereas the gneissic basement complex has been differentiated as a Precambrian? unit, pC (?).

Description

The basement complex contains both granite and gneiss. The granitic rocks weather to dark-gray rough surfaces, with jagged quartz grains projecting above the depressions caused by weathering of feldspar or dark minerals. The fresh granite is pink, gray, or dark green. Some fine-grained granite and aplite occurs, but about three-quarters is medium to coarse grained and contains 30 to 40 percent quartz, 50 to 60 percent feldspar, and lesser amounts of dark accessory minerals.

Associated with the gneiss are muscovite schist, metaquartzite, calc-silicate rock, metaconglomerate, and amphibolite. The gneissic rocks are dark, medium grained, and strongly foliated by growth of parallel micaceous minerals. The gneiss contains 30 to 40 percent quartz and 50 to 60 percent feldspar, the remainder being dark minerals.

Age and Correlation

Between the two southwestern prongs of the Moose River synclinorium the basement complex is unconformably overlain by fossiliferous beds of Ludlow age. In the southeastern part of the Kennebago Lake quadrangle Boudette has found conglomerates containing basement complex granitic rock types interbedded with C_3-C_5 age, Late Llandovery age fossiliferous strata indicating that the basement is probably of pre-Late Llandovery age as well.

Boucot (1961, p. 185) suggested that both the granitic and the gneissic (Arnold River Formation of Marleau, 1958) rocks of the basement complex might be of Precambrian age. Conversations with Albee, after Albee's work in the Attean quadrangle have made a correlation of the granitic basement complex rocks with the Middle Ordovician to pre-Late Llandovery Highlandcroft Plutonic Series of New Hampshire appear more reasonable.

The age of the gneissic basement complex still presents serious problems independent of the age of the granitic basement complex. On the east shore of Jim Pond, Spencer quadrangle, and in the wooded area to the northwest gneissic basement complex exposures approach within a few hundred yards of Cambrian or Ordovician rocks belonging in the chlorite zone. These two suites of rock types are separated by the southwesternmost tip of the Moose River synclinorium in the form of a narrow wedge of Hardwood Mountain Formation which is faulted on the southeast against Cambrian or Ordovician rocks. The extreme contrast in metamorphic grade, across a distance of a few hundred yards, from granitic gneiss to slate and phyllite would appear to make any but a structural juxtaposition very unlikely. The available information about the age of the Cambrian or Ordovician rocks is admittedly very slender, with only one fossil occurrence of Middle Ordovician age being known to the northeast between this area and Lobster Lake. The most reason-

able conclusion, when all of the above data are considered, now appears to be that the gneissic basement complex is of pre-Middle Ordovician, possible Precambrian age.

If the relatively unfossiliferous Lobster Mountain Volcanics inferred to overlie the basement complex in Somerset County are of Middle Ordovician age then the possibility exists that either the Highlandcroft will prove to be of relatively early Ordovician age, or pre-Ordovician age, or that the granitic basement complex of Somerset County is not a correlative of the Highlandcroft.

LOBSTER MOUNTAIN VOLCANICS

Boucot (1961, p. 182-183) defined a "Volcanic Rocks of Silurian or Ordovician Age" unit. Further reflection taken together with Heath's field work suggests that an Ordovician age would be more appropriate. Volcanic rocks of Early Silurian age are unknown in northern Maine, although fossiliferous Early Silurian beds have been recognized from northern Aroostook County southwest into Franklin County at several dozen localities. The nearest Early Silurian volcanics occur far to the north in the Temiscouata region where the associated and interlayered sedimentary rocks are distinctly different from anything encountered in west-central Maine. Ordovician volcanic rocks on the contrary are widespread in northern Maine, including such units as the Kennebec Formation of nearby Somerset County, unnamed volcanics in the Castle Hill and Winterville areas of Aroostook County, and un-named volcanics in northern Piscataquis County (Boucot, *et al.*, 1964).

The Lobster Mountain Volcanics occur beneath the strata of Silurian and Devonian age in three areas on the northwest side of the Moose River synclinorium and in one area on the southeast side. Since the present investigation touched on these volcanics only briefly, their relationships to each other and to the rocks associated with them are not clear.

Distribution

On the southeast side of the Moose River synclinorium these volcanics form the Lobster Mountains, which extend from the west shore of Little Claw on Lobster Lake southwest to Moosehead Lake in the vicinity of Big Dry Point, Moody Island, and Harris Cove. These rocks are bordered on the northwest by the Silurian and Devonian rocks of the Moose River synclinorium and on the southeast by rocks assigned to the Cambrian or Ordovician.

On the northwest side of the Moose River synclinorium rocks of this unit are exposed in Upper Enchanted Township (Pierce Pond quadrangle) between Grace Pond and the McKenney Ponds; in the area just north of Baker Pond, Hobbstown Township (Spencer quadrangle); and in Jim Pond Township (Chain Lakes quadrangle).

Thickness

Thicknesses of the Lobster Mountain Volcanics could not be measured directly, and the figures given are estimates based on width of outcrops. In the Lobster Mountain area estimates would range from a few thousand to 10,000 feet. If the scattered exposures of tuff and conglomerate on Moosehead Lake are parts of a continuous section, the stratigraphic thickness there would be about 10,000 feet, but information in that area is too inadequate to make the thickness determination reliable. In Upper Enchanted Township, thickness probably does not exceed 200 feet and may be as little as 50 feet. The volcanics near Baker Pond are probably 50 to 100 feet thick. In Jim Pond Township thickness is probably of the order of a few thousand feet.

Description

In the area of the Lobster Mountains, rock types include felsite, tuff, agglomerate, and greenstone. The felsite exposures are massive and irregularly jointed. The rock is light- to dark-colored, and flinty to granular in appearance, with abundant phenocrysts of feldspar and quartz. The thick chalky rind that develops on exposed surfaces presumably is caused by altered feldspar.

The following analysis of felsite from the Lobster Mountain area was made:

Analysis of felsite from the
Lobster Mountain Volcanics

Report No IWC-324 (Lab. No. 54-477-CWP).

(E. A. Nygaard, H. F. Phillips, and C. F. Ferreira, analysts)

	Percent
SiO_2	79.0
Al_2O_3	11.6
Total Fe as Fe_2O_3	1.6
MgO	0.15
CaO	0.13
Na_2O	4.6
K_2O	2.7
TiO_2	0.17
P_2O_5	0.01
MnO	0.08
Ignition*	0.70
Sum	101.
FeO	0.81
Fe_2O_3	0.70

Locality: Southwest side of Big Claw, Lobster Lake, North East Carry quadrangle, Piscataquis Co., Maine

* Includes gain due to oxidation of FeO

This analysis shows the felsite to be a rhyolite, though its high silica, low alumina, and excess of soda over potash distinguish it from others in this peraluminous province.

The tuffs and agglomerates are not conspicuously cut by cleavage planes, unlike the fine- to medium-grained rocks of associated formations. Bedding is poorly developed in the agglomerates; the tuffs, on the other hand, are evenly bedded in layers ranging from a few inches to a few feet in thickness. A few marine fossils have been found at one exposure on the west side of Little Claw (SD-3280) on Lobster Lake, but it is not clear whether these fossils are indigenous or reworked from an older formation.

The greenstone is light to dark green on fresh surfaces, rusty to dark-brown on weathered surfaces. Many specimens are aphanitic; others show phenocrysts of white feldspar and greenish ferromagnesian minerals.

In Upper Enchanted Township are light-green weathering, massive felsites with a green color in the fresh specimen. Phenocrysts of feldspar are visible in the hand specimen. In the field these rocks are easily mistaken for massive arkose including abundant fragments of greenish feldspar. Phenocrysts of greenish feldspar constitute about sixty percent of the rock, rounded phenocrysts of quartz about ten percent, dark minerals about five percent, and the remainder made up of fine-grained groundmass.

The exposures north of Baker Pond consist of light-violet weathering to rusty weathering rocks with a surface about one millimeter thick of white material which presumably represents altered feldspar. They are relatively massive and are cut by numerous fractures into irregular blocks. Bands of medium-grained tuffaceous debris indicate the attitude of bedding in some exposures. The fresh rock is light-violet in color, and consists of a fine-grained groundmass which includes about five percent feldspar phenocrysts and five percent quartz phenocrysts.

The volcanics in Jim Pond township are made up of a great variety of rocks. Light yellowish felsites and dark greenstones are most abundant. The felsites are white weathering, the outer rind being white and chalky probably due to alteration of the feldspar, contain a variable percentage of both quartz and feldspar phenocrysts in a fine-grained, yellowish groundmass, and have a flinty appearance. The greenstones are dark-green weathering, with limonitic material occurring in joints. They form rounded exposures, and consist largely of phenocrysts of dark-colored minerals and greenish feldspar in a fine-grained, greenish groundmass. Veinlets containing epidote and calcite are common in the dark greenstones. Some of the felsites contain garnet crystals, indicating the peraluminous composition of these rocks and their modal affinity with both younger and older rhyolites of Somerset and Piscataquis Counties.

Rhyolite from Lobster Mountain Volcanics
Lab. No. 146863

	Percent
SiO_2	80.0
Al_2O_3	12.3
Fe_2O_3	.19
FeO	.15
MgO	.18
CaO	.13
Na_2O	5.5
K_2O	1.0
TiO_2	.14
P_2O_5	.02
MnO	.01
H_2O	.52
CO_2	.05
Sum	100.

Southeast ninth of Chain Lakes quadrangle, Franklin County, Maine, 1.1 miles N51E from the outlet of Chase Pond, on the southwest spur of 1880 — foot hill.

Analyzed by: Paul L. D. Elmore
Katrine E. White
Samuel D. Botts

Contacts:

The upper contact of the Lobster Mountain Volcanics with the overlying Formations has not been observed. However, on the north side of Jackson Cove, Lobster township, North East Carry quadrangle, the basal Big Claw Member of the Lobster Lake Formation contains conglomerate in which many of the pebbles are made of felsite which may have been derived from the underlying volcanics. Felsite fragments are also abundant in the beds of the Big Claw Member on the west side of Lobster Lake. On the east side of Moosehead Lake the Lobster Mountain Volcanics are overlain by the Tarratine Formation, but the contact has not been observed. The attitude of the agglomerates and tuff on the southeast side of Jackson Cove is almost at right angles to that of the overlying strata of the Big Claw Member of the Lobster Lake Formation. It is concluded that the Lobster Mountain Volcanics probably rest with angular unconformity beneath the Big Claw Member at Jackson Cove, Lobster Lake. The attitudes of the strata in both the Lobster Mountain Formation and the overlying Tarratine Formation on Moosehead Lake are near vertical or vertical and are northeast trending. In conclusion it is likely that the Lobster Mountain Volcanics rest unconformabily beneath the overlying formations of Lower Paleozoic age.

Age and Correlation

The Lobster Mountain Volcanics have yielded fossils at only one locality, SD-3280, on the northeast flank of the Lobster Mountains where a single pedicle

valve of an unidentified dalmanellid brachiopod was found in association with a few pelmatozoan columnals. The presence of this shell suggests a Middle Ordovician or younger age determination. The presence of the angularly overlying Lobster Lake Formation provides an upper limit of Ludlow age. The absence of similar volcanic rocks in the widely distributed Late Llandovery age rocks of the region suggests that a pre-Late Llandovery age is reasonable. The presence of widespread Ordovician volcanic rocks in certain regions of northern Maine makes a Middle or Upper Ordovician age for these rocks reasonable, although an Early or Middle Llandovery age cannot be ruled out. Fossils have not been found to the southwest in these rocks in Somerset County, where their age relationships may well be similar. There is, however, as pointed out in the discussion of the Kennebec Formation, a possibility that the Kennebec is merely a small remnant of the Lobster Mountain Volcanics. The regional implications of such a conclusion, based as it would be at this time on entirely inadequate information, are too great to permit it to be anything more than a speculation.

CAMBRIAN OR ORDOVICIAN ROCKS

This term is used as defined by Boucot (1961, p. 183-184). It is extended to include similar rocks associated with the Roach River synclinorium.

Description

Slate and phyllite make up 50 to 70 percent of the rocks in this unit, dark sandstone and graywacke 20 to 30 percent, and light and dark volcanic rocks the remainder. Some carbonate rocks are also present.

The slate and phyllite are fine grained, with glittering micaceous minerals parallel to the cleavage. Most of the slate is dark gray and dark green, but some is black and some is interbedded red and green.

The dark sandstone and graywacke are fine to medium grained, massive, and poorly bedded. Beds are 6 inches to several feet thick. The rocks are blue-gray where fresh and weather either lighter or darker. The graywacke contains 5 to 10 percent pebbles of slate, quartzite, and dark sandstone, and 50 to 80 percent angular to poorly rounded sand-size feldspar grains, the remainder being fine-grained dark silt. The sandstone contains no pebbles and the quartz grains are better sorted. Both sandstone and graywacke are well indurated, and most sedimentary structures have been obliterated.

The light and dark volcanic rocks are associated in many places. These are flinty, with a rind of white chalky material, and contain feldspar and quartz phenocrysts. The dark-green volcanic rocks consist of chalky feldspar crystals interlocked with ferromagnesian minerals. Weathered parts are crumbly and iron stained.

Some light-gray argillaceous limestone beds occur in the unit.

Thickness

The thickness of these rocks is unknown, but they may be tens of thousands of feet thick.

Age

No fossils have been found in these rocks. On the east shore of Lobster Lake their reddish phyllite beds are overlain unconformably by the Lobster Lake Formation, which contains fossils of Silurian age. Near Somerset Junction the phyllites lie near the Kennebec Formation of Middle Ordovician age, but the relations are unknown. These rocks are probably of pre-Silurian age, as is indicated by the unconformity at Lobster Lake and their association with strata that are known to be Middle Ordovician, but they are probably not as old as Precambrian. They are here considered to be Cambrian or Ordovician.

INTRUSIVE ROCKS

TESCHENITE

Distribution

A single teschenite dike is exposed on the southeast side of Grannys Cap's northeast end.

Description

The dike, which is about six feet wide, intrudes massive felsite of the Heald Mountain Rhyolite. The rock is black, fine-grained, equigranular, and weathers spheroidally. The surface of the weathered rock is crumbly and the dike has weathered back relative to the more resistant massive felsite which it intrudes.

In thin section, it is seen to have a relatively equigranular texture. It is composed of labradorite, pink titaniferous augite, analcime, black oxides (either ilmenite or magnetite), plus accessory minerals which is consistent with its chemical analysis. This is the only dike or body of mafic rock in the Moose River synclinorium which intrudes rocks of pre-Acadian age, in which the minerals are relatively fresh and unaltered.

	Percent
SiO_2	46.6
Al_2O_3	15.3
Total Fe as Fe_2O_3	11.5
MgO	6.7
CaO	9.6
Na_2O	3.0
K_2O	0.86
TiO_2	2.0
P_2O_5	0.34
MnO	0.20

Ignition*	4.3
Sum	100.0

* Includes gain due to oxidation of FeO

FeO	5.6
Fe_2O_3	5.3

Analysts: E. A. Nygard
H. F. Phillips
C. P. Ferreira

(Lab. No. 52-487-CWP)

Age

The unaltered state of the minerals and the fact that the dike cuts Lower Devonian rhyolite suggest that it was intruded after the close of the Acadian orogeny. The chemical composition and mineralogy ally it with similar rocks in Aroostook County (Williams and Breger, 1900, p. 179-185), and the Chain Lakes Area (Boucot, *et al.*, 1959, p. 12-13) and in general to the silica deficient rocks of both the Monteregion type in nearby Quebec and the White Mountain type in New Hampshire.

GRANITE

Distribution

Post-Lower Devonian granitic rocks occur between Hog Island in Wood Pond, Attean quadrangle and Bean Brook, Long Pond quadrangle. The western limits of this body are unknown, but judging from the pattern of the magnetic intensity contours (Hurley and Thompson, 1950, pl. 1) it does not extend much farther west than Sally Mountain. The eastern limits of the granite are marked by the outcrop belt of the Seboomook Formation which consists of cordierite hornfels adjacent to the granite.

Description

The rock is medium to coarse-grained, usually pink or buff, contains quartz, potash feldspar, plagioclase feldspar, and muscovite, as well as minor amounts of accessory minerals. An approximate mode is: 70 percent feldspar, about 20 percent smoky quartz, about 5 percent muscovite and biotite, plus minor amounts of accessory minerals. The plagioclase is not so saussuritized as that in the basement complex. The actual contact of the granite with the Seboomook Formation has not been seen but large boulders on Hog Island include a contact between granite and hornfels, similar to the rocks in the bedrock, which is intrusive.

Age

The intrusive relationships of the granite and the hornfels of the Seboomook indicate that the granite is of post-Oriskany age. The relatively unaltered cordierite in the hornfels provides evidence that the granite was probably intruded after the Acadian orogeny had taken place.

It is concluded that the granite exposed near Jackman, (Hurley, *et al.*, 1959) which is responsible for the metamorphism of the nearby Seboomook Formation, is of Middle Devonian age, which would imply that the Acadian orogeny in this region is of Middle Devonian age.

INTRUSIVE RHYOLITE AFFILIATED WITH THE KINEO MEMBER

(Pl. 12, Fig. 3)

Distribution

Intrusive rhyolite affiliated both texturally, mineralogically, and chemically with the Kineo Volcanic Member is scattered throughout the strata of the Tarratine Formation in the Moose River synclinorium. The most prominent of these intrusives are located in the vicinity of Misery Pond, Cold Stream Mountain, Johnson Mountain, Coburn Mountain, Williams Mountain, Warren Camp, Cold Stream, Parlin Gorge, and the upper reaches of Salmon Stream. A similar sill intrudes the Hobbstown Formation in the core taken from northeast of Grace Pond, Pierce Pond quadrangle.

In the northeast part of the Roach River synclinorium similar rocks intrude both the Seboomook Formation and the Silurian undifferentiated. These include a sill and stock which extends from a point just west of the southwest tip of Big Spencer Mountain, Ragged Lake quadrangle; an irregularly shaped body east of Ragged Lake; and two small dikes on the shores of Ragged Lake, and one on the fire station road one-half mile northwest from the Bean Brook crossing.

Description

The intrusive rhyolite consists of both garnet rhyolite and fine-grained felsite.

Garnet rhyolite

Garnet rhyolite has been observed at eleven localities in association with the Tarratine Formation. Of these, the rhyolite bodies southeast of Misery Pond, on the east branch of Enchanted Stream, and southwest of Warren Camp are strongly discordant. At Misery Pond, in the area southwest of Misery Pond, in the valley of Cold Stream, and on Williams Mountain, the rhyolite is roughly conformable, exhibiting only slightly cross-cutting contacts. The rhyolites on Cold Stream Mountain, Johnson Mountain, and on Salmon Stream are also presumed to be roughly conformable. The rhyolite on Coburn Mountain is cross-cutting. It is likely that the bodies on Coburn Mountain, Johnson Mountain, and Salmon Stream are the exposed portions of a large body which is tabular and only slightly cross-cutting. Well developed columnar jointing has been observed in the body on Misery Pond, and from the west side of Coburn Mountain. In summary it is concluded

that eight of the eleven occurrences are tabular and slightly cross-cutting, whereas three are irregular in shape and strongly cross-cutting. In none of these bodies were chilled contacts observed. Lithologically, the garnet rhyolite from the bodies associated with the Tarratine Formation is identical to that of the Kineo Member. The thickness of these bodies ranges from seventy-five feet in the body on Misery Pond to perhaps six-hundred feet on Williams Mountain.

Topographically the larger bodies of intrusive garnet rhyolite give rise to eminences like Williams, Coburn, and Johnson Mountain with relief of from seven-hundred to fifteen-hundred feet.

Fine-grained felsite

In Parlin Gorge (Plate 20) several rhyolite dikes cut the Tarratine Formation. Their thickness ranges from four to ten feet. The rocks are white-weathering, massive, fine-grained, light-gray when fresh, and non-porphyritic.

Relationships between the Kineo Member and the Intrusive Rhyolites Associated with the Tarratine Formation, Seboomook Formation and Silurian Undifferentiated.

The unique peraluminous composition (Table 9) of the rhyolitic rocks associated with the Kineo and Tarratine plus the similar appearance in the field and the similar mineralogy strongly suggest that all the rocks are genetically related. It is notable that rhyolitic rocks have not been found associated with the main part of the Tomhegan Member.

The abnormally low silica content and unusually high alumina found in analyses eleven and twelve suggests that this rock may have been leached of a portion of its silica either during weathering shortly subsequent to extrusion or by hydrothermal solutions that might have accompanied metamorphism of the region during the Acadian orogeny.

DIORITE

Distribution

Dikes and sills of diorite are exposed on Enchanted Stream, one-third of a mile below the outlet of Enchanted Pond, Upper Enchanted township, Pierce Pond quadrangle; Gore Rapids, T4 and T3, R5, Spencer quadrangle; Little Spencer Stream between the dam on Spencer Lake and Parker Bog Brook, T3 R5, Spencer quadrangle; and on Cold Stream in the southern part of T2 R6, Pierce Pond quadrangle, the top of Burnt Hill, Flagstaff township, Spencer quadrangle; plus Little Spencer Mountain, North East Carry and Ragged Lake quadrangles.

Description

The sill on Enchanted Stream, which intrudes strata of the Tarratine Formation, is about two hundred feet thick. Its margins are chilled and aphanitic, and its median portions have a coarse-grained, equigranular texture. The rock contains augite, saussuritized calcic plagioclase (labradorite altering to oligoclase), epidote, leucoxene, pyrrhotite, black oxides (ilmenite or magnetite), carbonate, brown hornblende, and apatite.

The dikes and sills exposed in Gore Rapids are similar in aspect to the sill on Enchanted Stream, but they are too small to be shown on the geologic map (Boucot, *et al.*, 1959, map and p. 12). These dikes intrude both the Seboomook Formation and the Parker Bog Formation. The andesitic tuff of the Parker Bog Formation has been altered to garnet-diopside hornfels by these bodies but the Seboomook Formation has merely been bleached to a greenish quartzitic rock in Gore Rapids itself while upstream the effect of the dikes is hardly apparent.

The diorite on the top of Burnt Hill is topographically defined but resembles that previously mentioned. It is possible that the sills and dikes in Spencer Stream, including Gore Rapids, are genetically related to the apparently much larger body forming the top of Burnt Hill.

Age

The alteration of the calcic feldspars and pyroxenes in the diorite suggests that it antedates the Acadian orogeny, and is of Lower Devonian age because it also intrudes the Seboomook Formation which is of Late Helderberg and Oriskany age. The diorite may be genetically related to the diabase on both Jackman and Bean Brook Mountains, the latter representing a fine-grained phase of the same magma.

DIABASE

Distribution

Diabase caps both Bean Brook and Jackman Mountains, Long Pond quadrangle. This rock was first reported from the area by Pirsson and Schuchert (1914, p. 221-222), who described a body of diabase on "Parlin Mountain;" it is suggested that the diabase noted by them was that on either Bean Brook Mountain or Jackman Mountain.

Description

Although its contacts have never been observed, the diabase appears to be conformable with the strata of the Tarratine Formation with which it is associated. The estimated thickness of the body is about eight hundred feet to a feather edge. Whether the body is a flow or a sill is not known.

The texture of the diabase is ophitic and medium to fine grained. The color of the weathered rock is light-gray, that of the fresh rock is greenish-black. The weathered rock has a thin, one-eighth inch, chalky rind of altered material. Topographically

Table 9

Chemical Analyses of Rhyolites from the Kineo Rhyolite Member

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SiO_2	69.50	75.41	75.3	68.6	74.3	70.2	68.4	78.0	70.6	78.0	66.2	64.5	76.1	73.01
Al_2O_3	15.12	12.89	12.0	16.4	14.8	14.6	16.6	12.1	14.2	12.8	23.3	23.7	12.1	12.62
Fe_2O_3	2.00	0.08	3.8	3.4	1.0	5.0	5.0	2.6	4.5	2.6	1.1	1.5	1.4	1.55
FeO	3.55	1.79									2.8	2.9	3.0	2.45
MgO	0.76	0.01	0.46	1.1	0.20	1.1	1.2	0.26	0.50	0.38	0.26	0.28	0.76	0.44
CaO	1.28	1.09	0.24	0.58	0.21	1.2	0.49	0.18	0.86	0.17	0.03	0.03	0.05	1.22
Na_2O	2.33	2.87	2.9	0.36	4.2	2.7	1.0	4.1	3.6	0.78	0.31	0.12	0.80	3.80
K_2O	3.76	4.63	4.6	5.8	4.0	2.9	3.4	1.6	3.8	3.0	0.26	0.30	2.4	3.69
H_2O+	1.33	0.56												0.64
H_2O-	—	0.06												nil.
TiO_2	0.15	0.10	0.28	0.62	0.02	0.62	1.0	0.24	0.35	0.28	0.42	0.44	0.22	0.13
P_2O_5	—	0.12	0.04	0.38	0.00	0.16	0.22	0.08	0.28	0.01	0.02	0.02	0.02	—
MnO	0.05	0.06	0.01	0.01	0.32	0.09	0.12	0.06	0.12	0.01	0.01	0.01	0.01	0.07
Ignition			0.82	3.0	1.4	2.2	3.2	1.7	1.2	2.5				
Sum			100.00	100.00	100.00	101	101	101	100	101				
FeO			3.0	1.9	0.16	3.8	3.5	0.32	3.9	1.4				
Fe_2O_3			0.50	1.3	0.82	0.80	1.1	2.2	0.20	1.0				
H_2O											4.5	4.8	2.3	
CO_2											0.05	0.05	0.05	nil
Total	99.83	99.67									99	99	99	99.62

1 Coburn Mountain (intrusive)
2 Mount Kineo (extrusive)
3 Boucot locality 718, Misery Ridge (extrusive)
Stream exposure at elevation 1560 feet on southwest side of highest knob of Misery Ridge, Brassua Lake quadrangle, Somerset County, Maine
4 Boucot locality 61 (intrusive, garnet rhyolite)
0.1 mile S10W of 2380′ knob on SW end of Williams Mountain, Long Pond quadrangle, Somerset Co., Maine (intrusive, garnet rhyolite)
5 Dike 2, Rhyolite, Parlin Gorge (Plate 20)
6 Boucot locality 725, (garnet tuff)
West shore of Cold Stream Pond on point adjacent to upper right part of "*m*" in "*Cold Stream Pond,*" Long Pond quadrangle, Somerset Co., Maine
7 Felsite Pebble A B C, exposure on bank of Misery Stream about 0.2 mile N outlet of Misery Pond on Warren Camp trail, Brassua Lake quadrangle, Somerset Co., Maine
8 Boucot locality 1287, light tuff
Northwest side of knob situated under "*G*" of "*MISERY RIDGE*" about 0.15 mile from the "*G*", Brassua Lake quadrangle, Somerset County, Maine
9 Boucot locality 724, garnet rhyolite (extrusive)
400 feet south of locality 725 on west shore of Cold Stream Pond
10 Boucot locality 207 (flow)
Southwest shore of Brassua Lake from only rhyolite flow exposed on lakeshore (see Plate 13), Brassua Lake quadrangle, Somerset County, Maine.
11 Northeast side Big Duck Cove, North East Carry quadrangle, Piscataquis County, Maine
12 Northeast side of Big Duck Cove, North East Carry quadrangle, Piscataquis County, Maine
13 Big Duck Cove Mountain (top of Mountain)
North East Carry quadrangle, Piscataquis Co., Maine
14 Big Spencer Mountain (extrusive)

ANALYSTS

1 George J. Steele, General Electric Company (in Smith, 1933, p. 227)
2 Mary G. Keyes, Washington, D. C. (in Smith, 1933, p. 227)
3 Analysts: E. A. Nygaard, H. F. Phillips, C. P. Ferreira (Report No. IWC-324, Lab No. 52-478-CWP)
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12 Analysts: P. L. D. Elmore, K. E. White (Lab. No. 145951)
13 Analysts: P. L. D. Elmore, K. E. White (Lab. No. 145952)
14 George J. Steele, General Electric Company (in Smith, 1933, p. 228)

the rock supports the ridges on which it occurs, and gives rise to a relief of about one thousand feet.

The rock is composed of labradorite laths, largely altered, and pyroxene that is almost completely altered. The plagioclase, originally labradorite for the most part, is now altered to oligoclase and albite, together with some epidote. The dark minerals have largely altered to epidote, a chloritic mineral, and carbonate. Minerals present in minor amounts include quartz, apatite, chlorite, and black ore. The degree of alteration is not uniform; some thin sections show a completely altered rock, whereas others show only partial alteration.

The following analysis is consistent with the above mineralogy.

	Percent
SiO_2	60.1
Al_2O_3	14.8
Total Fe and Fe_2O_3	8.6
MgO	1.6
CaO	3.8
Na_2O	3.8
K_2O	3.0
TiO_2	1.0
P_2O_5	0.30
MnO	0.17
Ignition*	4.2
Sum	101.
FeO	6.6
Fe_2O_3	1.2

* (Include gain due to oxidation of FeO)

Analysts: E. A. Nygaard,
H. F. Phillips
C. P. Ferreira

(Lab No. 52-4860-CWP)

Age

The highly altered nature of parts of this rock suggests that it antedates the Acadian orogeny (thought to be largely responsible for the alteration) and, therefore, is possibly of Lower Devonian age. No diabase has been found associated with rocks younger than the Tarratine Formation.

METAMORPHISM

All of the sedimentary rocks mapped during the course of this study have been subjected to a low-grade regional metamorphism consequent with the tight folding and the development of a slaty cleavage. In addition, the aureoles around the areas of intrusive rock exhibit contact metamorphic effects.

REGIONAL METAMORPHISM

The regional metamorphism affecting the rocks of the Moose River and Roach River synclinoria is largely restricted to alteration of the fine-grained portions of the argillaceous sedimentary rocks. This fine-grained fraction has been recrystallized to a fine-grained mixture of "sericite," quartz, and untwinned feldspar. No attempt has been made to study the mineralogy or chemical composition of this fine-grained fraction. It was noted under the description of the intrusive rocks that both the diabase and the diorite found in the region have been altered with consequent development of epidote, oligoclase, and "sericite," plus carbonate, and this alteration is attributed to the low-grade metamorphism which the region has undergone. The andesitic felsite of the Parker Bog Formation, at its type locality, now consists of a mixture of actinolite needles, oligoclase, calcite, chlorite, and quartz as determined by means of X-ray powder diffraction. The dark siltstones and mudstones of the region frequently develop porphyroblasts of pyrite surrounded by pressure shadows of fibrous quartz. Porphyroblasts of calcite develop in some of the calcareous slates and have been rotated during formation as evidenced by the "snowball" inclusions they contain.

Samples of coal, described previously in connection with the Kineo Volcanic Member, are now anthracitic in rank. Many of the fossils in the dark sandstones of the region are coated with bronze-colored, parallel growths of a chloritic mineral. F. H. Hildebrand and R. L. Smith examined a sample of this chloritic material from the Tarratine Formation and report as follows: "Chlorite group mineral possibly a member of the sheridanite-ripidolite series . . ." "Although this mineral has the chlorite structure of the group indicated above, its indices are higher (beta about 1.685, 2V about twenty degrees) than those of the known chlorite minerals. It is possible that this is a new mineral . . ." In addition parallel growths of pyrite and albite have been noted on the fossils in dark sandstone at many localities. The occurrence of albite crystals appears to be a function of the amount of deformation suffered by the rocks as gently dipping beds containing relatively undistorted fossils do not yield albite overgrowths whereas vertical beds containing more deformed fossils usually yield fossils with albite overgrowths. Joints in the felsite of the Parker Bog Formation at its type locality are coated with an asbestiform mineral which M. L. Lindberg reports (Sample No. 52-21 41M) "is a member of the tremolite-actinolite series . . ." The mineral composition of the felsitic portions of the Parker Bog Formation is actinolite, oligoclase, quartz, calcite and chlorite.

The available evidence suggests that the rocks of the two synclinoria are in the lower part of the chlorite zone of regional metamorphism particularly as indicated by the conversion of the mafic igneous rocks into greenstones, although this conversion has not been complete even within any one body. It was noted that the intensity of the metamorphism, including development of albite crystals, pyrite and

calcite porphyroblasts, and micaceous minerals on cleavage planes seemed to be a function of the amount of deformation suffered by the rocks; slightly deformed rocks being far less altered than highly deformed ones.

Time of Regional Metamorphism

It was noted that the Kennebec Formation and the Cambrian and Ordovician rocks are slightly more phyllitic than the nearby Silurian and Lower Devonian rocks. From this it is inferred that the Taconic or earlier orogenies in this region may have given rise to low grade (chlorite zone) metamorphism upon which the later Acadian orogeny superimposed another phase of low grade metamorphism which was not as intense as the preceding. In general the pre-Silurian rocks have a more deformed appearance, fossils are rarer, and brecciation is more abundant; all of these phenomena possibly being due to the combined effects of a Taconic or earlier orogenies succeeded by the Acadian orogeny.

CONTACT METAMORPHISM

Lime-silicate hornfels has been observed in connection with the Silurian rocks on Limestone Hill and the Parker Bog Formation in Gore Rapids. Cordierite hornfels of the Seboomook Formation occurs in the area between Wood Pond and Bean Brook. A biotite-cordierite hornfels of the Seboomook Formation occurs on the south end of Deer Island. Arenaceous limestone of the Beck Pond Limestone near Beck Pond has been prehnitized adjacent to a diabase contact.

Lime-Silicate Hornfels on Limestone Hill

Location

Lime-silicate hornfels occurs on the top and summit of Limestone Hill, Stratton quadrangle, Somerset County. Fine-grained, light, fossiliferous hornfels was observed on the top of the hill and fine-grained, dark hornfels containing lenses of garnet on the southern end of the hill in roadcuts (Pankiwskyj, 1959).

Description

The fine-grained, light hornfels on the summit of the hill contains fossils, which have been altered to coarse-grained calcite, in a matrix which C. Milton (Report No. IWM-565) reports as consisting of . . . an aggregate of quartz and diopside, with minute areas of coarser diopside and calcite; also turbid potassic feldspar." The appearance of the rock in the field suggested that it was a calcareous siltstone similar to those described from the Hardwood Mountain Formation. Milton's report is consistent with contact metamorphism of a calcareous siltstone by means of the dark granitic rocks which occur immediately to the east of Limestone Hill.

The fine-grained dark hornfels contains zoned ellipsoids made up largely of garnet rimmed by various lime-rich silicates. The zoned ellipsoids appear to have been pebbles of stretched, impure limestone, and the fine-grained, dark matrix to have been a calcareous siltstone similar to that of the Hardwood Mountain Formation prior to metamorphism. C. Milton (Report IWM-565) examined the rock and reported as follows regarding one of the zoned ellipsoids: "... an inner core of pink isotropic garnet as an aggregate of rounded grains. Interstitial to these is secondary quartz, calcite, and epidote-zoisite. Bordering the inner garnet zone is a thin pale green epidotic zone, interspersed with detrital quartz. This is followed by a zone in which the siltstone shows a microscopic development of poikilitic zoisite in elongated crystals whose outer extensions are completely replaced by green hornblende."

Age

The hornfels on the summit of Limestone Hill contains fossils of Silurian age, but the time of the metamorphism cannot be more accurately defined than post-Late Llandovery. However, the unaltered condition of the pyroxene and amphibole in the hornfels suggests that the metamorphism occurred after the post-Lower Devonian orogeny which affected the region and may be of Acadian age. Elsewhere in this area are regionally metamorphosed rocks, mapped by Griscom, which are believed (Boucot, *et al.*, 1964) to be equivalent to the Seboomook Formation.

Cordierite Hornfels of the Seboomook Formation

(Pl. 10, Figs. 1-2)

Location

Cordierite hornfels occurs between Wood Pond, Attean quadrangle, Somerset County, and Bean Brook, Long Pond quadrangle, Somerset County. The width of outcrop, which does not exceed one-half mile, traces a sinuous course bounding the area of younger granitic rocks to the west.

Description

The cordierite hornfels of the Seboomook Formation is similar to unmetamorphosed exposures of that unit except for the presence of numerous small, two to four millimeter, spherical to ellipsoidal porphyroblasts. In thin section these porphyroblasts are seen to be cyclicly twinned cordierite. The remainder of the hornfels is very fine-grained, but probably consists largely of quartz, micaceous minerals and cordierite. The alteration of the rock has not resulted in any loss of original sedimentary structures like graded bedding, but rather, has tended to intensify and "freshen" these features. The cordierite porphyroblasts are largely restricted to the less arenaceous laminae.

Age

The Seboomook Formation in this area is of Oriskany age, and it is presumed that the hornfels is genetically related to the nearby younger granitic rocks which, in turn, are inferred to be of Acadian age (Hurley, *et al.*, 1959).

Biotite-Cordierite Hornfels

Location

Biotite-cordierite hornfels occurs on the southwest end of Deer Island, Moosehead Lake quadrangle.

Description

The rock is gray weathering, fine-grained, and contains large, three to ten millimeter knots which weather out in relief. In thin section the rock is seen to contain abundant biotite with dark, reddish-brown pleochroism, plus a large amount of material, resembling quartz or oligoclase. Examination of the material which resembled quartz or oligoclase, by means of X-ray powder diffraction demonstrates that it is made up largely of quartz and cordierite. Most of this material is very fine-grained and difficult to identify by optical methods.

Age

The adjacent unmetamorphosed rocks have been identified as Seboomook Formation, which suggests that the hornfels is of post-Oriskany age, and probably also post-dates the Acadian orogeny.

Prehnitized Arenaceous Limestone

Location

Prehnitized, arenaceous limestone, belonging to the Beck Pond Limestone occurs just to the north of Beck Pond at fossil locality SD-3497.

Description

The unmetamorphosed rock at this locality consists of arenaceous limestone containing abundant fossils. Quartz grains make up about fifty percent of the rock. Veinlets of black, lustrous material, about one-quarter inch in thickness, are associated with the limestone within a few feet of the contact with intruding diabase. The "veinlets" were determined to consist of black, twinned, prehnite replacing the calcite of the limestone, but not the quartz grains which remain imbedded in the prehnite. The prehnite was identified by means of X-ray powder diffraction pictures. C. Milton checked a thin section of the material and concurs in the identification of the material as prehnite.

Age

The age of the intruding diabase is not known except as post-Helderberg (Boucot, Harper, and Rhea, 1959, p. 22).

STRUCTURE

GENERAL STATEMENT

The rocks of northwestern Maine considered in this report belong to portions of seven major structural units. To the northwest (Pl. 13) the first structural unit consists of the pre-Silurian basement complex. Southeast of this basement complex unit is the Moose River synclinorium, consisting chiefly of Lower Devonian rocks but with subsidiary Silurian and Ordovician strata associated. The next unit beyond the Moose River synclinorium consists of presumed older rocks here termed the Lobster Mountain Anticlinorium, chiefly Cambrian or Ordovician rocks and the Lobster Mountain Volcanics occurring as a narrow belt between the synclinorium to the northwest and the Roach River synclinorium to the southeast. The region southeast of the Roach River synclinorium is largely occupied by bodies of young-er intrusive rocks which partly cut off the southeast side of the syncline.

At the northeast end of the Roach River synclinorium is the Caribou Lake anticline. Two major faults, the Ragged Stream and Spencer Mountain faults cut portions of the region.

The southeast boundary of the Moose River synclinorium is an unconformity for an unspecified distance to the southwest. Southwest from the Chase Pond region in the 10,000 Acre Tract the contact becomes a thrust fault. The Northwestern boundary of the Moose River synclinorium consists of both unconformities and major faults.

BASEMENT COMPLEX UNIT

Location

The Basement Complex unit includes the outcrop belt of the rocks assigned to the basement complex northwest of the major synclinal structure. The boundary of the unit extends from Little Big Wood Pond southeast to the vicinity of Bean Brook Mountain and southwest again to the Jim Pond region.

Structure

The Basement Complex unit is made up of pre-Silurian rocks which are surrounded to the northwest, northeast, and southeast by rocks of post-Ordovician age. Very little is known of the internal structure of the unit. The southeastern boundary of the unit from Bean Brook Mountain to Jim Pond is an angular unconformity between the basement complex and a mantle of Silurian and Devonian rocks. The boundary in the Little Big Wood Pond area is also an unconformity.

Age

The time of formation of the unit is poorly known. Because the Seboomook Formation is involved in the folding along the southeast boundary it is clear that

the unit moved up relative to the Moose River synclinorium in post-Lower Devonian time. The younger granite in the Wood Pond area has been radiometrically dated as Middle Devonian (Hurley, *et al.*, 1959) and cuts the Seboomook Formation, which suggests that the region was strongly affected by the Acadian orogeny. The basement complex portion of the unit has been intermittently positive since at least the beginning of Hardwood Mountain or possibly Early Silurian time as well as during the interval when Somerset Island was shedding sediment to the surrounding region during Devonian time.

MOOSE RIVER SYNCLINORIUM

Location

The Moose River synclinorium lies between the Lobster Lake, Piscataquis County and Jim Pond, Franklin County areas, for a maximum length of about sixty-seven miles. The greatest width of the synclinorium is along the section southeast from the area of Little Big Wood Pond where it is twenty some miles wide. The northeastern end of the synclinorium is relatively narrow, whereas the southwestern end is wider and bifurcates into two prongs against the basement complex. The northwestern prong terminates in the vicinity of Little Big Wood Pond and the southeastern prong in the vicinity of Jim Pond.

Structure

The synclinorium is essentially a double plunging canoe-shaped, asymmetric trough whose southwestern terminus is bilobate. The core of the structure is adjacent to the narrow southeast limb of the synclinorium whereas the northwest limb has been highly complicated by folding and occupies a far wider belt of outcrop than its corresponding member to the southeast.

The average plunge of the axis of the synclinorium is about three or four degrees, to the northeast or southwest, but the observed plunges associated with the many minor folds can be much greater (vertical bedding-cleavage intersections have been observed).

The minor anticlines southeast of the structure's axis have steeply dipping northwestern limbs and less steeply dipping southeastern limbs; the reverse is true for the anticlines northwest of the synclinorium's axis.

The prominent shear cleavage planes southeast of the synclinorium's axis dip steeply to the southeast while their counterparts northwest of this axis dip steeply to the northwest.

Steeply dipping joints which strike at right angles to the fold axes are very prominent in the synclinorium.

No major faults within the synclinorium have been identified, but minor dislocations and displacements parallel to the well-developed fracture cleavage are very common.

Southeast Boundary

The southeast boundary of the synclinorium is marked by an angular unconformity for an unspecified distance southwest from Lobster Lake. The actual unconformity has been observed on the east side of Lobster Lake and is described under the section dealing with the Big Claw Member of the Lobster Lake Formation.

Southwest of Little Spencer Stream the Silurian undifferentiated is inferred to be missing because of a high angle, southeast dipping fault which is also responsible for the overturning of the Parker Bog Formation in Gore Rapids (Boucot, Griffin, Denton, Perry, 1959) and for the omission of the basal calcareous siltstone of the Hardwood Mountain Formation in the Jim Pond area. In the Jim Pond area the calcareous beds of the Hardwood Mountain Formation adjacent to the fault are much sheared, markedly more phyllitic and micaceous than equivalent strata no more than two miles to the northwest and are cut by numerous veinlets of calcite, and thrown into a very complex pattern of minor folds. The slip on the fault is not accurately known, but the intensity of the deformation appears to be increasing in a southwesterly direction. In the Jim Pond area the stratigraphic slip is at least several hundred feet, and might be as much as several thousand. On the northeast shore of Jim Pond calcareous, fossiliferous, strongly sheared phyllite of the Hardwood Mountain Formation occurs about one-hundred yards southeast of undeformed strata belonging to the unit. The sheared phyllite is immediately adjacent to the fault.

An intensive drilling program (Hurley, oral communication, 1960) along and across this contact in the 10,000 Acre Tract area has shown the presence of a wide fault zone filled with sheared material and gouge separating the pre-Silurian from the Post-Ordovician age rocks. The amount of displacement along this shear zone is unknown but its magnitude suggests that the fault is an important structural element. The acute linearity of the contact suggests that the contact deviates very little from the vertical along its entire length.

Folds Within the Moose River Synclinorium

Within the synclinorium several major structural units (Plate 22) can be defined. The most southeasterly of these is the Misery syncline, which extends from the Heald Mountain area northeast to Warren Camp and thence to a point just northwest of Mount Kineo. Its near-vertical southern limb is very prominent topographically, partly because of the chain of large rhyolite bodies strung out along

it. The Tarratine Formation is brought to the present erosion surface by a large doubly plunging anticline southwest of Warren Camp. This anticline splits the Misery syncline into two branches, one in the vicinity of Chase Stream Pond, the other south of McDonald Camp.

Northwest of the Misery syncline is the Williams Mountain anticline, a complex structure containing doubly plunging minor folds. The main branch of the Williams Mountain anticline extends from Coburn Mountain through Williams Mountain to a point one mile south of Brassua Station. Here the main anticlinal axis is offset one-half mile to the southeast, whence it continues through Brassua Lake to the west shore of Moosehead Lake before dying out to the northeast. The northwest branch of the Williams Mountain anticline begins one mile north of Williams Mountain, from which it can be readily traced through a point one and one-half miles west of Brassua Station to Moosehead Lake; disappearing to the northwest of Shaw Mountain. The syncline between the main part of the Williams Mountain anticline and its northwest branch is of minor importance near Williams Mountain, but it becomes progressively more important toward Moosehead Lake. This structural feature is called the Tomhegan syncline because it is well demonstrated along the west shore of Moosehead Lake in the southeast corner of Tomhegan township. Northeast of this last point the Tomhegan syncline joins the Baker Brook syncline at a point northwest of Norcross Mountain.

Northwest of the Williams Mountain anticline is the Baker Brook syncline, which extends from the area northwest of Norcross Mountain southwest to Baker Brook Point to Brassua Lake (in the vicinity of which the axis is offset one-half mile), Moose River, and the eastern end of Long Pond, thence to Parlin Pond. From Parlin Pond the axis of the fold continues to the northwest side of Coburn Mountain, and it probably is expressed in the vicinity of Enchanted Pond as a zone of crushing and minor drag folding.

The Baker Brook and Tomhegan synclines, joined together near Norcross Mountain, may be thought of as being interwoven with the two branches of the Williams Mountain anticline, the latter being joined just north of Williams Mountain.

Northwest of the Baker Brook syncline little is known of the major structures in the synclinorium. The degree of folding, however, remains about the same. The presence of several major structures within the rocks of the Seboomook Formation is suggested by the cross-section extending from Seboomook Dam to the southeast but the lateral extent and course of these structures is not known.

The crests of the anticlines and the troughs of the synclines are sites of more intense fracturing than the limbs (Fig. 8 shows a structural detail from the trough of the Tomhegan syncline). Where exposed, they show minor faulting and a host of slickensided displacements, with net slips usually tens of feet or less. The Misery Quartzite Member, where exposed on the crest of the minor anticline near Warren Camp, is brecciated and recemented with milky quartz to a much greater degree than elsewhere.

Misery Quartzite

The behavior of the Misery Quartzite during deformation suggests that its quartzitic texture was acquired before regional folding. During deformation, the quartzite was shattered and subsequently recemented by milky quartz. The dark sandstone of the Tarratine Formation, on the other hand, was not fractured extensively during folding and it contains few quartz veins.

Opposing opinions on the origin of these quartz veins are held by E. S. C. Smith (1925), who associated the quartz veining with the supposed intrusion of nearby rhyolite, and by Hurley and Thompson (1950), who inferred that at least some of the veining was due to silicification adjacent to a fault zone.

SPENCER MOUNTAIN OUTLIER
(Pl. 11, Fig. 2)

Location

The Spencer Mountain outlier of the Moose River synclinorium is situated northwest of the southwesternmost prong of the synclinorium. The outlier's southeastern margin is about two miles to the northwest of the synclinorium's main body. The outlier has a maximum width of about three miles, an average width of about one mile, and a length of about ten miles. The northeasternmost portion of the outlier is situated to the northwest of Spencer Mountain, and the southwesternmost portion is situated near the mouth of Kibby Stream.

Structure

The outlier is most simply considered as a portion of the former sedimentary cover of a portion of the basement complex which has been preserved by downfaulting along its southeastern margin. The northwestern margin of the outlier, from Hardwood Mountain on the northeast to Kibby Stream on the southwest is an unconformity between strata of the Hardwood Mountain Formation and granitic rocks of the basement complex. The fault along the outlier's southeastern margin, here named the Spencer Mountain fault, has a very straight trace. The straight trace of the fault suggests that it has a very steep angle of inclination, which suggestion was partially confirmed at the locality on Spencer Mountain where the fault was excavated. Excavation through a thin veneer of glacial drift at one locality on Spen-

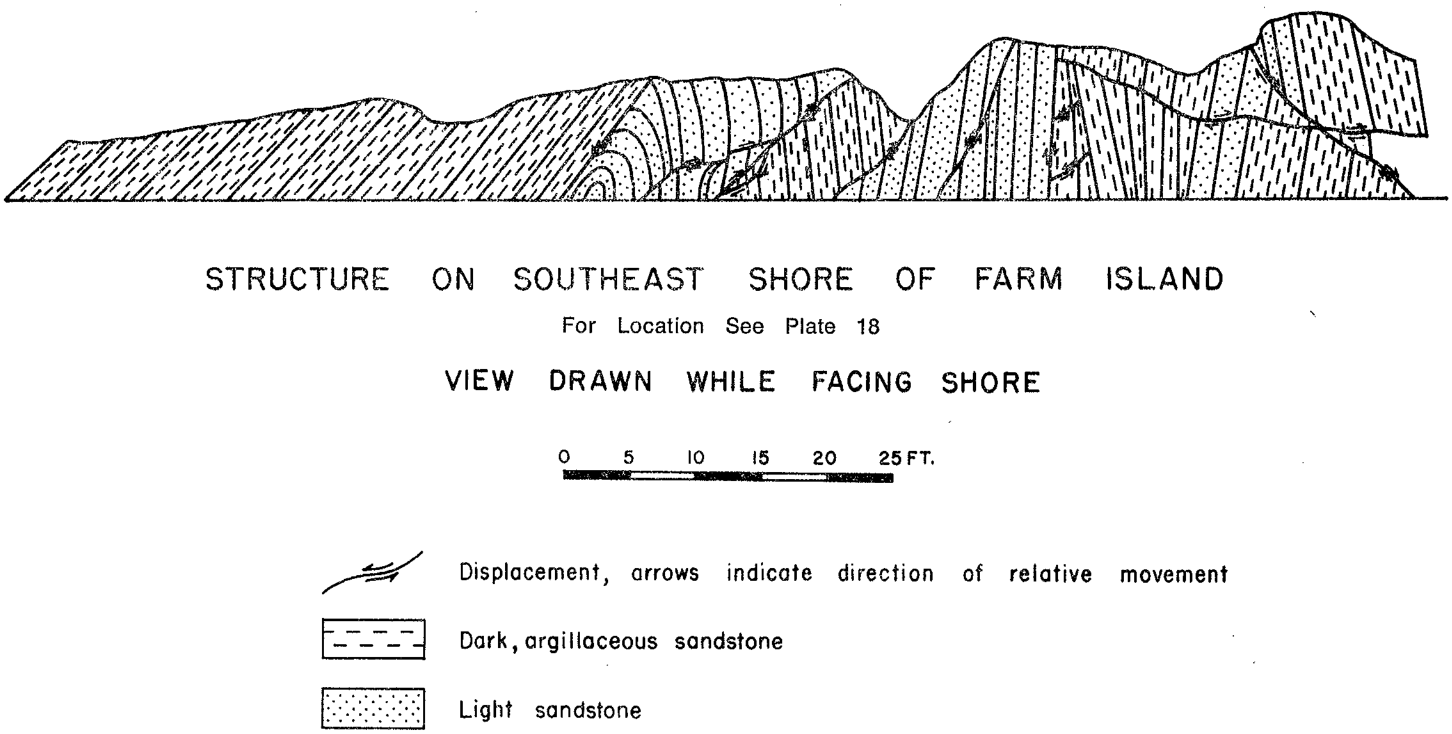


FIG. 8. Structure on the southeast shore of Farm Island.

cer Mountain laid bare the actual fault plane. The fault at this locality is vertical with basement complex granitic rocks in a somewhat brecciated condition on its southeastern margin and slate of the Hardwood Mountain Formation dipping southeasterly at about sixty degrees on its other side. No evidence for metamorphism was found at this locality, but it was notable that thin films of slaty material have been injected between some of the brecciated granite fragments. Southeast of the contact between the Hardwood Mountain Formation and the basement complex one finds a variable width, up to a maximum of several hundred yards, in which brecciated granitic rocks of the basement complex are present. These breccias are difficult, at first, to discriminate from the arkose of the associated Hobbstown Formation, but more intimate acquaintance in the field with both rocks resolves the problem. The fault breccias consist almost entirely of angular material, never containing any cobbles of calcareous siltstone or limestone of Hardwood Mountain lithology. The fault breccias do, however, contain a certain amount of calcareous material in the cement which binds them together, and this calcareous material may originally have been derived from the Hardwood Mountain Formation. Dr. Charles Milton examined several exposures of both arkose belonging to the Hobbstown Formation and breccia belonging to the fault zone, obtained specimens from these exposures which he subsequently examined petrographically and concluded that the breccia was of cataclastic origin. Almost every exposure of the Hobbstown Formation in this area contains a limited percentage of coarse material which was probably obtained from the Hardwood Mountain Formation.

The net slip on the Spencer Mountain fault has not been determined, but the stratigraphic slip has a minimum value of at least two thousand feet.

Northwest of Spencer Mountain the outlier has been complicated by the presence of a subsidiary fault which partly parallels the Spencer Mountain fault. This subsidiary fault parallels the main fault in its course to the southwest of Hardwood Mountain but turns in an easterly direction to join the main fault further to the northeast. The subsidiary fault has resulted in the downfaulting of the northwesternmost remnant in the outlier and also has resulted in the preservation of a narrow band of the Hardwood Mountain Formation which surrounds a small area of basement complex, on three sides, northwest of the main fault. The net slip on the subsidiary fault is much greater as the main fault is approached, resulting in a hinge-type movement in which the pivotal point was probably near the northern end of Baker Pond where the net slip of the subsidiary fault is only a fraction of its value to the northwest. It is difficult to determine the actual value of the net slip for the subsidiary fault but its stratigraphic slip on the northeast amounts to at least several thousand feet, whereas its stratigraphic slip to the southwest is probably no more than a few hundred feet.

The strata of the Hardwood Mountain to the northwest of the subsidiary fault possess relatively gentle inclinations. The strata of both the Hard-

wood Mountain and Hobbstown Formations between the subsidiary fault and the Spencer Mountain fault have relatively gentle inclinations to the northwest which rapidly increase as the main fault is approached. The inclination of bedding within one-half mile of the fault is about fifty degrees at most localities.

The actual plane of the subsidiary fault has not been observed, and a suitable locality for excavation was not located during the course of the field work.

The basement complex rocks southeast of the Spencer Mountain fault, between Spencer Mountain and King and Bartlett Mountain contain many small veinlets filled with sandstone. These veinlets usually average no more than an inch in width and a foot or two in length. The veinlets may represent small clastic dikes along which movement occurred during the same episode which was responsible for the formation of the Spencer Mountain fault.

Age

The Spencer Mountain fault cuts strata of the Hardwood Mountain Formation and is overlain by strata of the Hobbstown Formation. It has been shown conclusively that the Hardwood Mountain Formation is of Late Silurian age, but the age of the Hobbstown Formation is less certain. The Basal Conglomerate Member of the Hobbstown Formation contains fossils of Late Silurian age, which are concluded to have been reworked from the underlying Hardwood Mountain Formation. The Hobbstown Formation has been found in the Camera Hill area to have possible facies relationships with the basal portion of the Seboomook Formation which is of Oriskany age and to contain Early Devonian fossils. Therefore, it has been concluded that the Hobbstown Formation is of Early Devonian age. It has not been proved that all the rocks assigned to the Hobbstown Formation are contemporaneous, which further complicates the dating of the Spencer Mountain fault. It is possible that the lens of Hobbstown Formation in the Camera Hill area was derived from an adjacent part of the basement complex which had been faulted up shortly before the beginning of Seboomook time whereas the bulk of the unit in the Spencer Mountain area had been deposited slightly earlier.

The available evidence, both structural and stratigraphic, suggests that the Spencer Mountain fault is a purely local feature associated with the positive nature of Somerset Island throughout much of Silurian and Devonian time. It is, in fact, tempting to think that the positive character of Somerset Island was largely due to faults of the Spencer Mountain type, but such a conclusion would be premature until the entire basement complex region has been subjected to careful study.

LOBSTER MOUNTAIN ANTICLINORIUM

Location

The Lobster Mountain anticlinorium consists of a narrow belt of pre-Silurian rocks situated between the Moose River synclinorium to the northwest and the Roach River synclinorium to the southeast. The anticlinorium never has a width of more than about seven miles, and probably never less than about four miles (Boucot, *et al.*, 1964). However, the southeastern limit of the unit is very poorly defined southwest of Moosehead Lake. In the area of The Forks, at Moxie Falls and in the village of The Forks, there are strata consisting of impure, crinoidal limestone which resemble those included with the Silurian undifferentiated. These strata include Wenlock age fossils at a site discussed earlier. In the Stratton and Kennebago quadrangles there occur Early Silurian fossil localities, previously discussed in the section dealing with stratigraphy, which set a southeastern boundary for the unit. It is possible that all the above occurrences of Silurian rocks may properly fall within the bounds of the Roach River synclinorium, but insufficient information is yet at hand to make such a conclusion, except in the general sense that an area of younger rocks appears to border the anticlinorium to the southeast wherever any information relative to age has been found.

The Lobster Mountain anticlinorium is formally terminated in the Moosehead Lake region due to the complications brought about by the Squaw Mountain intrusive mass, but it is probable that the structure extends further southwest (Boucot, *et al.*, 1964).

Structure

Nothing is known of the internal structure of the rocks, chiefly Cambrian or Ordovician which pertain to the anticlinorium. The observed attitudes of bedding and cleavage planes are very steep, usually not departing more than twenty degrees from the vertical, which suggests that the folds which may have affected these rocks are almost isoclinal. The northwestern boundary of the unit, as previously discussed, is an angular unconformity in the Lobster Lake area wherein the older rocks of the anticlinorium lie beneath the post-Ordovician rocks of the Moose River synclinorium. To the southwest when at least the 10,000 Acre Tract is reached, the contact becomes a thrust fault, in which the rocks here assigned to the Cambrian or Ordovician have been thrust to the northwest, over the rocks contained in the synclinorium. A notable pre-Silurian horizon in the southwest, near Jim Pond, is a series of interbedded red and green slates which are well exposed in the bed of Tim Brook and in the old road, situated in the southwestern corner of the Spencer quadrangle, which leads from The Chimes across the headwaters of Bradbury Brook toward Eustis. These red and green slates are vertically inclined, directly on strike with each other, and suggest that the Lob-

ster Mountain anticlinorium continues to the southwest at least as far as Tim Pond.

As a general rule the rocks of the anticlinorium appear to be more altered and regionally metamorphosed than those of the adjacent Moose River and Roach River synclinoria. It is possible that this apparent greater degree of metamorphism is due to their having been affected by pre-Late Llandovery age metamorphism during the Taconic orogeny, or that they are composed of material which alters more easily when subjected to the same treatment which the adjacent, younger, rocks have also received.

The southeastern boundary of the unit has not been studied in detail, and its nature is not known, except insofar as it appears to be relatively linear in nature.

Age

The rocks of the anticlinorium were affected by the Taconic orogeny, which is of pre-Late Llandovery age in this region, as demonstrated by the angular unconformity involving the Big Claw Member of the Lobster Lake Formation and the underlying phyllite of the Cambrian or Ordovician.

The presence of the Kennebec Formation of Middle Ordovician age suggests that the orogeny was restricted to the time interval between the Middle Ordovician and the beginning of Late Llandovery time in this region.

The thrust fault which bounds the anticlinorium on the northwest is of post-Seboomook age and probably should be associated with the Acadian orogeny of Middle Devonian time which is inferred to have have been responsible for the last major deformation in this region.

ROACH RIVER SYNCLINORIUM

Location

Lying to the east and southeast, essentially paralleling the Lobster Mountain anticlinorium, is the Roach River synclinorium. It extends from the Ragged Lake area, Ragged Lake quadrangle, southwest to southern Moosehead Lake, Moosehead Lake quadrangle. Scattered fossil localities to the southwest of the Moosehead Lake area, and scattered occurrences of rock types similar to those included within the synclinorium suggest that the region to the southwest may be either a continuation of the synclinorium or that additional, similar structures occur along strike and contain rocks of similar age and lithology.

Structure

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, is about N35E. In the Roach River area, First Roach Pond quadrangle, to the southwest, the strike of the axis has changed to about N45E.

The Roach River synclinorium has been traced for a distance of 24 miles. Its northern extremity has not been mapped. The plunge at the northern end of the mapped area is about 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 15 degree plunge is maintained southwesterly 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 and the northeast plunging anticline present in that area. At this point the Roach River synclinorium bifurcates, the two traces striking into the intrusive complex making up Squaw Mountain.

The greatest width attained by the Roach River synclinorium is about seven miles. This width narrows to about five miles at the northern end of the synclinorium. In the Roach River area the width is questionable owing to the presence of granitic intrusives which cut the southeastern limb of the synclinorium.

Age

The rocks of the Roach River synclinorium were tightly folded in post-Kineo time and subsequently intruded on the southeast by granitic rocks of probable Middle Devonian age.

CARIBOU LAKE ANTICLINE

Location

The Caribou Lake anticline extends from the northern Caribou Lake - Quaker Brook area, Ragged Lake quadrangle southeast to the Ragged Stream Fault. Its continuation on the southeast side of the Ragged Stream fault extends southeasterly to be cut off shortly by the Katahdin Batholith, with a southwestern extension to the vicinity of Farrar Mountain, First Roach Pond quadrangle.

Structure

The anticline lies east and southeast of the Roach River synclinorium and strikes almost at right angles to the trend of the Lobster Mountain anticlinorium.

The axial trace of the Caribou Lake anticline north of the Ragged Stream fault strikes N40W, and is concluded to extend for at least 10 miles, plunging to the northwest at about 10 degrees along its length. The exact form and location of the nose of the anticline is unknown since no traverses were

made into this region. Griscom (in Boucot, *et al.*, 1964) mapped a continuation of the anticline on the southeast side of the Ragged Stream fault to the vicinity of Ripogenus Dam, Harrington Lake quadrangle, where it is cut off by the Katahdin Batholith. The western limb of the anticline, southeast of the Ragged Stream fault has been carried well southwest of Grant Farm, Ragged Lake quadrangle, to the area of Farrar Mountain, First Roach Pond quadrangle, where Espenshade (written communication, 1966) has found a southwest plunging nose of the structure.

Age

The Caribou Lake anticline involves rocks similar in age to those present in the other major structures of the region. Like them it is concluded to be of Acadian, probably Middle Devonian age.

RAGGED STREAM FAULT

Location

The Ragged Stream fault has been mapped from the area of Holme's Hole, Ragged Lake quadrangle, southwest to the Bear Pond Brook area where it is lost in the Seboomook Formation. To the northeast it probably extends further than Holme's Hole in order to intersect the northwest trending band of Silurian rocks mapped by Griscom (in Boucot, *et al.*, 1964) in the Ripogenus Dam area, Harrington Lake quadrangle.

Structure

The fault cuts southwesterly across the Caribou Lake anticline. In the area of Ragged Lake Dam, to the southwest, the fault begins to parallel bedding and becomes relatively longitudinal. The fault has a strike of about N35E. The fault has been traced over a distance of about 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 show the presence of a thin sliver of undifferentiated Silurian rocks. The fault plane in these exposures dips essentially vertically, 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.

The southern termination of the fault is concluded to be in the great thickness of Seboomook Formation located in the Roach River synclinorium. Basal conglomerate and white quartzite present in the lower part of the Silurian undifferentiated were not found within the Silurian present on either side of the fault within the Roach River synclinorium itself. The fault sliver present on the southwest shore of Caribou Lake contains the white orthoquartzitic sandstone, basal conglomerate, and limestone of the Silurian undifferentiated, all of which rest unconformably to the southeast upon the Cambrian and Ordovician. Boucot (1954, p. 145) mapped a small exposure of Silurian limestone on the west shore of Chesuncook Lake opposite Holmes Hole. This exposure is interpreted as an isolated sliver caught between the main Ragged Stream fault and a parallel secondary fault. Presumably this sliver was first vertically displaced downwards by faulting as a graben; then left in its present position when the main body of the southern block was moved to the northeast relative to the northern block which was displaced to the southwest.

Graphic calculations and measurements made directly from the geologic map position and attitude of the Silurian undifferentiated on the opposing limbs of the Caribou Lake anticline give the following results, relative to the Ragged Stream fault which cuts the anticline. The beds in the north block are displaced southwest with respect to those in the south block. 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 Silurian undifferentiated diagonally at the point where the strike of the Silurian changes from northwest to southwest. This results in the peculiar map distribution of the Silurian and complicates the measurement of displacement in the area.

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 the Seboomook Formation at both ends.

Age

The Ragged Stream fault cuts the Seboomook Formation suggesting that it may be of roughly the same age as the major fold structures of the region.

MINOR STRUCTURES

The tightly folded and deformed rocks of northwestern Maine have developed a variety of secondary structures which are useful in trying to unravel the structure of the region. Included in this category are shear cleavage, drag folds, deformed fossils, stretched pebbles, boudinage, tension fractures, and rotated porphyroblasts.

Cleavage

Cleavage (Pl. 11, Fig. 1) is a prominent structural feature of all the stratified units studied. The individual planes are steeply inclined, the inclination being a function of rock type and the attitude of the containing unit. The cleavage planes observed in interbedded fine-grained rocks and medium- to coarse-grained rocks have a steepness of dip which is a function of grain size; the steeper dips being restricted to the fine-grained rocks, to give the individual outcrops the appearance of having continuous refracted cleavage planes at each bedding plane between bands of fine-grained and medium-grained strata.

It was previously mentioned that the Moose River synclinorium is characterized by an inverted cleavage fan in which the dips found in the southeastern half are to the southeast and the inverse for the northwestern half. None of the other structural units have been studied in sufficient detail for any information about the pattern of cleavage to emerge, other than the fact that steeply dipping cleavage planes are the rule. Bedding planes which are cut by the planes of fracture cleavage assume a rippled appearance. The actual amount of movement along each fracture cleavage plane is seldom more than a millimeter. The cleavage planes which cut fine-grained rocks are coated with glittering, micaceous minerals. The coarser-grained rocks display little or no evidence that micaceous minerals have been developed along the cleavage planes.

The fracture cleavage planes are not folded except in a few localities near Jackman where the cyclicly banded beds of the Seboomook Formation are cut by fracture cleavage planes which themselves are crinkled. Some of the fracture cleavage planes in the pre-Silurian rocks are cut by a second cleavage which has wrinkled the older cleavage planes. The second cleavage which cuts the fracture cleavage is shallowly inclined, but has been studied in too few localities for any detailed information regarding its relationship to the regional structure to have been obtained.

Cleavage relationships in the Roach River synclinorium are probably similar to those within the adjoining Moose River synclinorium, but the sampling in the former is not nearly as good as in the latter. The strikes of cleavage planes within the Silurian and younger formations roughly parallel structural trends except around plunging fold noses, where the planes are diagonal to the fold axes. Cleavage attitudes in the Cambrian or Ordovician are more random, perhaps a result of refolding during the Acadian orogeny.

Drag folds

Drag folds are not uncommon in the Moose River and Roach River synclinoria. The sense of the drag folds is consistent with that shown by the bedding-cleavage relationships. Study of most drag folds shows that they are formed by a combination of thickening and thinning of the involved beds plus a certain amount of differential movement along the fracture cleavage planes which cut the folds. Neither the plunge of individual drag folds, nor of the intersection of bedding and cleavage, gives an accurate picture of the regional plunge.

Drag folds have not been observed in enough localities, as compared with fracture cleavage, to afford much information regarding the tops and bottoms of the folded beds.

Deformed fossils

Deformed fossils (Pl. 12, Fig. 1) are found at nearly every fossil locality in the Moose River synclinorium and in the Roach River synclinorium. The deformation of the fossils is due to shear which has affected them during the folding of the containing rocks. The amount of differential shear does not appear to exceed about thirty degrees; i.e., an originally straight line may be deformed in these rocks up to about thirty degrees from its original position as in the twisted fold of a spiriferoid or a median rib in any plicated brachiopod. Originally spherical brachiopods have, in some cases been flattened up to three times their original size. It is probable that most of this deformation took place long after the strata had been lithified because the effects of load do not result in the shearing of fossils.

Stretched pebbles

Stretched pebbles (Pl. 12, Fig. 2) are prominent in the Silurian undifferentiated which, in addition to being a more plastic rock, is situated structurally in a far more deformed position than are similar rocks in the area. The direction of greatest pebble lengthening is normal to the direction of bedding-cleavage intersections in the bedding plane.

The pebbles in the carbonate rocks of the Silurian undifferentiated are greatly deformed into elongate ellipsoids possessing knife-like extremities. It was estimated in the field that many of the limestone pebbles have been flattened as much as three times their original size.

The felsite and granite pebbles of the basal conglomerate member of the Hobbstown Formation are indented to a minor degree, but the amount of deformation probably does not exceed ten percent. In addition to flattening of some of the pebbles it was

noted that others had been affected by fracturing, some of the resulting joints being still open. Cursory examination suggests that the felsites are more plastic in their behavior locally than are the associated pebbles of granite.

Boudinage

Prominent boudinage has been observed in only one locality, the railroad cut on the west shore of Moosehead Lake at fossil locality SD-2815, where strata of the Silurian undifferentiated are present. At this locality the calcareous phyllites and impure limestones have ruptured along lines which parallel the intersection of bedding and cleavage. These calcareous rocks were necked down considerably prior to actual rupture.

Tension fractures

The most prominent joints in the region are a set of steeply dipping fractures with attitudes normal to the intersection of bedding and cleavage. The fractures are often filled with coarse-grained minerals. The joints in the calcareous rocks are filled with calcite, those in the quartzites with milky quartz, those in siltstones and slates with a mixture of quartz and chlorite, those in the calcareous slates with a mixture of quartz, chlorite and calcite, and L. Pavlides has shown the writer similar fractures in the manganiferous rocks of Aroostook County which are filled with rhodochrosite. All of the aforegoing suggests that the material filling these tension fractures was derived by lateral secretion from the nearby country rock and that deep-seated sources have not played a part in forming the fillings.

Rotated porphyroblasts

Porphyroblastic pyrite and ankerite (rhombohedral carbonate which weathers to a rusty color) are present in strongly deformed rocks of the appropriate composition. The pyrite usually is surrounded by a pressure shadow of fibrous quartz, but no oriented samples were obtained from which the direction of rotation could be determined. Porphyroblasts of ankerite in which the trains of inclusions show evidence for rotation during growth are present in some of the calcareous phyllites and slates of both the Seboomook Formation and the Cambrian or Ordovician on the southeast side of the Moose River synclinorium. The direction of rotation is normal to the intersection of bedding and cleavage. Fragments of anthracite coal from the Kineo Volcanic Member are surrounded by pressure shadows of fibrous quartz similar to those found around pyrite.

Summary

All of the minor structures studied in this region are consistent with a picture of folding in which the rocks have been elongated parallel to the direction of the cleavage-bedding intersection as evidenced by the tension fractures, and also strongly compressed normal to this direction. Flattening has occurred in the bedding planes normal to the direction of the bedding-cleavage intersection, as evidenced by flattened fossils, stretched pebbles, and boudinage. Rotation of particles has occurred by both the development of folds and by the rolling of individual mineral grains.

Mechanism of folding

It is obvious from the geologic map (Pls. 13-14) and cross-sections that this region has been strongly folded, but the mechanism responsible for the folding is not obvious. There is good evidence, previously reviewed, that the folded rocks have been greatly elongated, possibly as much as three times, in the plane of bedding and normal to the intersection of bedding and cleavage. Unfortunately no quantitative studies were made which would enable one to estimate the actual percent of overall lengthening as opposed to the overall shortening caused by folding. In any event the evidence does not permit one to conclude that the crust in this area has been radically shortened by folding. It is conceivable that folding has been accomplished with little or no shortening. If such is indeed the case one would have to appeal to differential vertical movements as a cause of the folding. The relative elevation of the basement complex unit plus the present position of the Lobster Mountain anticlinorium is consistent with this hypothesis, but until more information is available concerning the geology of this region it would be very premature to make any conclusions regarding the mechanism of folding.

LARGE SCALE MAPS

A series of large scale maps were prepared for selected portions of the Moose River synclinorium. The mapping was done by pace and compass or steel tape and compass methods along sections of essentially no relief (lake shores, etc.) or of very limited relief (lower reaches of streams). These maps will be found useful for locating fossil localities, structural features, and sites from which specimens for rock analysis were obtained.

Tape and compass map and Columnar Section of shore of Moosehead Lake north of Moose River, Brassua Lake quadrangle, Maine (Plate 17).

The map area includes a large portion of the type section of the main part of the Tomhegan Formation. It is notable that the shear cleavage in the northern part of the map area is inclined to the northwest and that in the southern part to the southeast, bearing out the fact that the axis of the Moose River synclinorium extends through the map area. The strata in the middle part of the map area are very highly deformed and broken by a host of minor displacements which could not be shown on the map

due to their small scale. The minor displacements can be largely interpreted as shear cleavage planes along which at least a few feet of movement has taken place. It was not found possible to trace or recognize any one stratum from one exposure to another which suggests that the strata extend laterally for short distances only.

Tape and compass map and cross section and Columnar Section along railroad east of Tarratine, Brassua Lake quadrangle, Maine (Plate 15).

The map area is situated on the southeastern side of the Moose River synclinorium and includes the type section of the Tarratine Formation, including the Misery Quartzite Member. Shear cleavage planes dip to the southeast as is characteristic for the southeastern half of the synclinorium. The northwest limbs of anticlines are near vertical and the southeastern limbs more gently inclined as is also characteristic of the southeastern half of the synclinorium. Minor folds are present at the southeastern part of the map area, together with minor high angle faults. The high angle faults are actually shear cleavage planes along which a few feet of movement has occurred rather than the normal millimeter or fraction thereof. Fossils from locality SD-2690 are flattened to at least three times their original thickness.

Tape and compass map and Columnar Section of southeast shore of Farm Island, Moosehead Lake, Brassua Lake quadrangle, Maine (Plate 18).

The strata on the northern two-thirds of the map belong to a monoclinal sequence of gray-weathering dark sandstone of the main part of the Tomhegan Formation which is apparently uncomplicated by faulting and is cut by shear cleavage planes which dip to the northwest. The strata on the south half of the map area are rusty-weathering beds of the Tomhegan which are chopped up by a series of minor faults and are cut by shear cleavage planes which dip mainly to the southeast. It is inferred that the axis of the Moose River synclinorium is situated between the two areas of rusty-weathering and gray-weathering strata as indicated by the differing cleavage attitudes as well as the position relative to major structural elements of the region. From the standpoint of the inclination of bedding the map area belongs structurally to the southeastern half of the synclinorium as the beds to the north dip southeast at relatively low angles whereas those to the south are near vertical for the most part. The beds to the north contain fossils belonging to the *Amphigenia* Community and those to the southeast to the *Globithyris* Community. The high degree of faulting which the beds to the south exhibit is interpreted as due to minor faulting, viz., differential movements, on the vertical limb of a fold, possibly just below an anticlinal crest or adjacent to a synclinal trough.

Tape and compass map and Columnar Section of outcrops at village of Rockwood, Moosehead Lake quadrangle, Maine (Plate 23).

It is notable that few of the strata of the Tarratine Formation appear to be continuous along strike for more than a few hundred feet in those areas where there are enough exposures to check on lateral extent. From a structural point of view all of the strata form part of the southeast, near vertical, limb of the Moose River synclinorium. Shear cleavage planes dip southeasterly as is usual on the southeast half of the synclinorium. No evidence of drag folds was found in the map area.

Pace and compass map of Seboomook Formation strata along shore of Moosehead Lake, west of Center Island, Somerset County, Maine (Plate 24).

The map area is of interest as the shear cleavage planes dip to the northwest in conformity with the generalization that the cleavage planes in the northwestern half of the synclinorium dip to the northwest as opposed to those on the southeast side which dip to the southeast. The strata at the south end of the map have been more extensively plicated than those to the north, but the absence of near vertical bedding planes suggests that the plicated strata are all situated on the crest of an anticline whose southeast limb is south of the map area.

Tape and compass map and Columnar Section downstream from dam on Parlin Stream, Long Pond quadrangle, Maine (Plate 20).

This map is notable in depicting the change of strike in slightly tilted strata of the Tarratine Formation. A change in strike of about thirty-five degrees is present between SD-2719 and SD-2720. This change may be explained as due to rotation of the strata, during folding, relative to each other with a point to the south being the hinge. The fact that the cleavage planes near the dam have a strike in conformity with the bedding as do those downstream suggests that rotation of the strata has taken place along a minor fault plane. However, no breccia or mylonite was observed, although the junction of the two areas of differing strike is covered, possibly concealing such evidence. The variabilities in strike observed elsewhere in this area may be due to original irregularities of the surfaces on which the strata were laid down or to minor flexures developed during folding. The relatively massive nature of the dark sandstone and quartzite precludes the development of shear cleavage in most localities. The fossils occurring in the map area are relatively undeformed.

Pace and compass sketch map and cross section along Misery Stream below highest dam, Brassua Lake quadrangle, Maine (Plate 25).

Shear cleavage planes in the area of the map dip mainly to the southeast in conformity with the attitudes found elsewhere in the southeastern half of

the Moose River synclinorium. The southeast limb of the minor fold situated near the dam has a relatively low dip, from twenty to thirty-five degrees, whereas the northwest limb is nearly vertical or vertical in conformity with the observation that the northwest limbs of anticlines situated in the southeastern half of the synclinorium are usually near vertical whereas the southeast limbs are gently dipping. The presence of a minor fold is indicated downstream by the presence of both low and high dips of bedding and the distribution of the conglomerate of the Kineo Volcanic Member relative to the strata of the main part of the Tomhegan Formation.

Tape and compass map and Columnar Section downstream from lowest dam on Misery Stream, Brassua quadrangle, Maine (Plate 16).

The section of the main part of the Tomhegan Formation occurring below the lowest dam on Misery Stream is of structural interest because it is situated on the southeast side of the Moose River synclinorium. Shear cleavage planes are inclined mainly to the southeast, as is characteristic in this portion of the synclinorium. It is notable that no small-scale drag folds were detected along the entire portion of the fold limb mapped. The fossils occurring in the interbedded slate layers are badly deformed, having undergone flattening up to three times their original thickness. The strike of the strata changes from about northeast near the dam to about east-northeast downstream, which suggests that the dam is situated closer to the northeast plunging nose of a syncline than is the downstream portion. The variability of the strike of the shear cleavage planes can best be explained by taking into account the lithology of the most abundant rock, rusty-weathering mudstone, which tends to be broken up into a series of ellipsoids by the cleavage planes. The attitude of the cleavage planes associated with these polygons is variable within the limits suggested by the map, there being no evidence that the fold axis in this area is sinuous. The fossils occurring in ironstone concretions at SD-2713 are undeformed relative to the associated specimens in interlayered slate.

Tape and compass map of southwest shore of Long Pond, Long Pond Quadrangle (Plates 26-28).

The map of the southwest shore of Long Pond is almost entirely in folded strata of the Seboomook Formation which grade laterally, on the east, into thin-bedded slate and dark sandstone of the Tarratine Formation. Fossils are almost entirely restricted to the Tarratine Formation and to the more arenaceous beds of the Seboomook Formation situated within a few hundred yards of the formational contact.

It is notable that shear cleavage planes dip steeply to the northwest in conformity with the structural position of this area on the northwest side of the Moose River synclinorium. The whole area of the map encompasses only a few hundred feet of strata which have been intricately plicated but are essentially part of the northwest, gently dipping limb of an anticline. There is a marked tendency in this map area for the Seboomook Formation to become less arenaceous at right angles to the boundary with the Tarratine Formation. This tendency manifests itself in the increasing difficulty with which the geologist can make out the attitude of bedding at the western end of the map as compared with the eastern end, because of the rarity of arenaceous laminae in the predominantly argillaceous rock.

Tape and compass map along Cold Stream, Pierce Pond quadrangle, Somerset County (Plate 29).

Structurally the map area is situated along the southeast side of the Moose River synclinorium. The contact of the Seboomook Formation with the underlying Silurian undifferentiated is marked by a minor displacement along which occur veinlets of milky quartz. It is considered that no more than a few tens of feet of movement have occurred along this displacement, but it has destroyed all evidence at this locality of the nature of the original sedimentary contact. The actual contact was excavated in a pit dug on the west side of the stream. The contact with the overlying Tarratine Formation is covered. There is a tendency for the higher beds of the Seboomook Formation in this section to contain more arenaceous laminae than the lower strata. A number of minor displacements cut the rocks of the Seboomook Formation. Several small intrusive bodies of diorite cut the Tarratine Formation at one locality. No evidence for duplication of the section by folding was observed. It is notable that the shear cleavage planes in this section dip largely to the northwest which is inconsistent with the regional trends on the southeast side of the Moose River synclinorium elsewhere. No explanation for this phenomenon is advanced.

SOMERSET ISLAND

Name

Somerset Island is named after the area of pre-Late Silurian basement complex in Somerset and Franklin Counties, Maine, which is interpreted to have been the site of an island which existed during much of Late Silurian and Early Devonian time in this region.

Location

The northeastern and southeastern limits of Somerset Island during the Late Silurian and Early Devonian are interpreted as having been as follows: Little Big Wood Pond, Bean Brook Mountain, McKenney Ponds, Spencer Lake area, and Camera Hill area. The northwestern and southwestern boun-

daries are poorly known. The southwestern boundary, however, is interpreted to have been between the Camera Hill and Jim Pond areas. The position of the northwestern boundary is inferred to have been southeast of the northwestern edge of the Boundary Mountains which delimit the Quebec-Maine boundary in this region.

Form of the Island

The lithofacies information suggests that the area of maximum relief, that from which the coarsest debris was derived, existed in the northeast and southeast parts of the island, and did not extend to the southwest, past the area of Camera Hill. The almost total lack of coarse debris derived from the island to the northeast and northwest suggests that the island possessed very little relief in these directions.

Evidence Upon Which the Existence of Somerset Island is Based

Local unconformities

One of the more striking features associated with the area of basement complex in Somerset and Franklin counties, Maine, is the occurrence of stratigraphic units of different age resting upon it in different localities. In the area of Little Big Wood Pond the Hardwood Mountain Formation rests directly upon the granitic rocks of the basement complex. The basal beds of the Hardwood Mountain consist of coarse arkose, which is succeeded by calcareous slate, and limestone conglomerate. Immediately succeeding the Hardwood Mountain Formation, of Ludlow and Pridoli, Late Silurian age is the Seboomook Formation of Oriskany, Middle Early Devonian age, which includes pebbles of limestone and a few of basement complex granite in its basal bed, or alternatively the Hobbstown Formation, of Early Devonian age, on Sally Mountain.

In the Bean Brook Mountain area the Hobbstown Formation, of Oriskany age, lies between the Tarratine Formation of Oriskany age, and the basement complex. No fossiliferous rocks of pre-Oriskany age are known in the Bean Brook area.

The McKenney Ponds Member of the Tarratine Formation rests directly on granitic basement complex southwest of the McKenney Ponds. No strata of pre-McKenney Ponds, i.e., Oriskany age are present in this area.

Southwest of the McKenney Ponds area, in the vicinity of Beck Pond, strata of Helderberg age are interposed between the granitic basement complex and the overlying Seboomook Formation (of Helderberg and Oriskany age). Southwest of the Beck Pond area strata of Helderberg age are absent beneath the Seboomook; their place being taken by the Hardwood Mountain Formation of Late Silurian age.

In the Spencer Mountain area the Hardwood Mountain Formation rests unconformably upon basement complex rocks, but is itself overlain unconformably by the Hobbstown Formation. The basal Hobbstown Formation in this area contains fossils of Late Silurian age which are probably of approximately the same age as those in the underlying Hardwood Mountain Formation but are concluded to have been reworked from the underlying unit.

Late Llandovery age fossils have been identified in lime-silicate hornfels from Limestone Hill in the Stratton quadrangle and from near Blanchard Pond in the Kennebago quadrangle, both these localities being less than ten miles southeast of the Moose River synclinorium. Wenlock age strata occur about five miles to the southeast in The Forks quadrangle.

In summary it can be stated that no rocks of proved Llandovery or Wenlock age lie on the basement complex, although rocks of this age are known a short distance to the southeast. The occurrence of pre-Ludlow age rocks in this location suggests that they might once have been deposited in the basement complex area, but were subsequently removed by erosion, or alternatively a basement complex land area was merely bordered to the southeast by the Llandovery and Wenlock sea and contributed sediment to it. Three scattered areas of Ludlow-Pridoli age rocks are known (Jim Pond, Spencer Mountain, and Little Big Wood Pond) in which the Silurian rocks rest directly upon older basement complex. Rocks of proved Helderberg (early Early Devonian) age occur in only one locality, and rest directly on the basement complex. Rocks of Oriskany age (Seboomook Formation, Hobbstown Formation, Tarratine Formation) rest directly on the basement complex where rocks of pre-Oriskany age are absent, as is the case for about eighty percent of the area. The Seboomook Formation, of Oriskany age, also rests disconformably upon the Hardwood Mountain Formation and disconformably upon the Beck Pond Limestone.

It is concluded that the basement complex area in Somerset and Franklin Counties, Maine, is bounded by Silurian and Devonian rocks of widely differing age which rest unconformably upon the basement and upon each other. These unconformities appear to be purely local in nature.

Lithofacies relationships

Evidence for the existence of Somerset Island during the Silurian and Devonian is afforded by the facies relationships within the various units which rest upon the basement complex area. The rocks containing the coarsest basement complex debris are interpreted as having been derived from nearby basement complex areas possessing relatively high relief, whereas those containing finer debris are interpreted as either having been farther removed from this source of coarse debris or to have been

adjacent to basement complex areas of relatively low relief.

The Early Silurian rocks southeast of the Moose River synclinorium consist of lime silicate hornfels which were originally calcareous siltstones. No relatively coarse-grained rocks of Early Silurian age have been found in the Moose River synclinorium. Such rocks would be expected to occur midway between the known exposures of Early Silurian rocks and the northwest boundary of the synclinorium in the Spencer quadrangle.

The basal beds of the Hardwood Mountain Formation (Late Silurian) in the area of Little Big Wood Pond and Spencer Mountain consist of relatively coarse-grained calcareous arkose. The basal beds of this unit southwest of Spencer Mountain, between Baker Pond and Jim Pond consist of medium to fine-grained, calcareous siltstone. It is concluded that the area of greatest relief in the basement complex during the beginning of Hardwood Mountain time existed between Little Big Wood Pond and Spencer Mountain; an area of low relief or one actually covered by the sea existing elsewhere at this time. The higher beds of the Hardwood Mountain consist chiefly of medium to fine-grained, arenaceous and calcareous rocks, which suggests that the basement complex was not contributing much coarse debris at this time, or for that matter, that much of the basement complex area was above sea level.

The Hobbstown Formation whose basal beds in the Spencer Mountain and Camera Hill areas contain fossils of Late Silurian and Devonian age respectively, consists of very coarse granitic debris, rests unconformably upon the Hardwood Mountain Formation. An interval of faulting intervened between the deposition of these two units and gave rise to relief, as estimated from the stratigraphic slip on the faults, which was of the order of several thousand feet. Coarse debris assigned to the Hobbstown is found on the east side of Sally Mountain, the west side of Bean Brook Mountain, in the Spencer Mountain area, and in the vicinity of Camera Hill. It is clear that shortly after the end of Hardwood Mountain time the basement complex area from Sally Mountain and Bean Brook Mountain to the Camera Hill region was subject to great uplift and erosion, during which erosion the bulk of the Hardwood Mountain Formation was presumably removed. Fragments of calcareous siltstone and limestone of Hardwood Mountain lithology have been found in some of the conglomerates of the Hobbstown Formation. The coarsest conglomerates of the Hobbstown Formation are found on the slopes of Spencer Mountain, one block of granite has a diameter of about twelve feet, but the fragments in these conglomerates rapidly decrease in size and the degree of rounding increases to the northwest. From this information it is concluded that the Spencer Mountain area possessed great relief during Hobbstown time, and that relief was much less away from Spencer Mountain. The presence of a lens of arkose in the Camera Hill area suggests that a local source, possessing high relief may have been responsible.

The limited area of the Beck Pond Limestone contains rocks of several lithologies, including relatively pure limestone, impure limestone containing abundant detrital, quartz, feldspar, and granite pebbles and calcareous conglomerate containing large granite boulders. The restricted known distribution of the Beck Pond Limestone is probably due to a combination of erosion prior to the beginning of Oriskany time which may have removed the bulk of the older unit plus the possibility that the seas of Beck Pond time did not extend much farther to the northwest locally than Beck Pond (Boucot, Harper, Rhea, 1966).

The strata of Oriskany age include the Seboomook Formation which consists predominantly of cyclicly banded slate, the Hobbstown Formation of Bean Brook Mountain, and the Tarratine Formation which consists largely of dark sandstone. The Tarratine Formation is localized on the southeast side of the basement complex area, from Bean Brook Mountain southwest to the Spencer Lake area. The Tarratine Formation is from two to three times as thick adjacent to the area of basement complex as away from it, which suggests that the source area lay immediately to the northwest and west. The absence of dark sandstone in large amounts in the Seboomook Formation suggests that this unit was further removed from the source which supplied the material making up the Tarratine Formation. Rocks of Seboomook lithology occur on the northwest side of the Boundary Mountains and are interpreted by Boucot to belong to the Seboomook Formation. The conglomeratic Bear Pond Member of the Seboomook Formation, containing basement complex debris, requires the presence for at least a short interval of a local topographic high serving as source.

Fossil Cliff
(Pl. 6, Figs. 2-3)

In the basement complex about one-half mile south of Baker Pond, Spencer quadrangle, were found joints in the basement which are filled with conglomerate. The conglomerate is made up largely of rounded to angular basement complex rocks but includes some boulders of calcareous siltstone and limestone similar to those of the Hardwood Mountain Formation. Some of the joints are as much as a yard in width.

In other localities, as on the southwest end of King and Bartlett Mountain and the east side of King and Bartlett Lake are found patches of conglomerate which resemble that found south of Baker Pond.

These scattered occurrences of conglomerate are interpreted as the remnants of fossil cliffs and coarse, bouldery talus which collected after the

interval of faulting which affected the Hardwood Mountain Formation and subsequent to which the Hobbstown Formation was deposited. The filled joints near Baker Pond may actually be the remnants of sea stacks.

Community Relations

The occurrence of Big Shell Community in the McKenney Ponds Member is consistent with a shoreline or near shoreline occurrence of Oriskany age. The *Eccentricosta* Community present in the Hardwood Mountain Formation of the Jackman area is also consistent with a very shallow water region as contrasted with the presence of *Kirkidium* in the Lobster Lake Formation, a Community element normally expected seaward of the *Eccentricosta*-bearing beds.

Conclusion

The presence of numerous local unconformities, the removal by erosion of some of the older Silurian units prior to Helderberg and Oriskany time, the lithofacies relationships in both Silurian and Devonian time, the thickness relationships within the Tarratine Formation, and the presence of possible fossil cliffs can best be explained in terms of an island, made of basement complex, which intermittently was rejuvenated, and possessed greatest relief in the region between Sally Mountain to Bean Brook Mountain and Spencer Lake. More detailed work to the northwest of the Boundary Mountains may provide additional information bearing on the limit of the island.

LOBSTER ISLAND

The data for the inference of a Lobster Island during the Early Devonian in Somerset and Piscataquis Counties are far less satisfactory than for the existence of Somerset Island. However, the presence of Big Shell Community at one locality in Rockwood and the absence of calcareous pre-Tarratine age beds as well as the absence of the Seboomook from somewhat southwest of Moosehead Lake to northeast of Big Duck Cove is consistent with the presence of an island in the Lobster Mountain region which was uplifted enough during post-Lobster Lake pre-Seboomook time to allow for the removal of the Lobster Lake Formation, and during Seboomook-Tarratine time to permit only the deposition of Tarratine type sand which is inferred to reflect an environment closer to a source than is the Seboomook type of strata. The thinning and eventual pinching out of the Misery Member in both synclinoria is also consistent with this interpretation.

HISTORICAL GEOLOGY

PRE-ORISKANY AGE HISTORY

The oldest rocks in northwestern Maine are considered to belong to the basement complex as exposed in western Somerset and northern Franklin Counties. The basement complex, consisting of granitic, gneissic, and metamorphosed rocks, had been highly metamorphosed prior to the deposition of any locally fossiliferous strata of Paleozoic age. It is inferred that the gneissic basement complex is of Precambrian age. The granitic basement is inferred to be of Middle Ordovician to Early Silurian age. No definitive information is available regarding the age relationships of the metamorphosed and granitic rocks, except that the amphibolites associated with the granitic rocks appear to have gradational relations with the host rocks. The nearest basement complex rocks of proved Precambrian age are situated in the core of the Green Mountain anticlinorium (Mount Holly Complex, see Brace, 1953).

The oldest proved Paleozoic rocks in northern Maine are of Ordovician age, but associated with them are a variety of strata, from which fossils have not yet been obtained, which might be of Cambrian age. In northwestern Maine the rhyolitic tuffs and felsite of the Kennebec Formation contain marine fossils of Middle Ordovician age. Associated with the Kennebec Formation, on the southeast side of the Moose River synclinorium, are a variety of strata which are inferred to be of Cambrian or Ordovician age. The strata on the southeast side of the Moose River synclinorium rest unconformably beneath beds of Silurian age and appear to be more metamorphosed than the overlying strata of Silurian and Devonian age. Similar relationships exist in the Roach River synclinorium and the Caribou Lake anticline. The Cambrian or Ordovician rocks contain a variety of types. Slate, phyllite, and dark sandstone are the predominant lithologies, but graywacke plus both light and dark volcanic rocks are abundant. The pre-Silurian rocks northwest of Logan's line in nearby Quebec consist predominantly of calcareous strata, mainly calcareous shale, calcareous sandstone, and impure limestone. The pre-Silurian rocks southeast of the Roach River synclinorium are similar to the above in Piscataquis County, but to the southeast in Somerset County they consist of a monotonous succession of slate, phyllite, subgraywacke, and siltstone intimately associated with similar-appearing strata of post-Ordovician age. This belt of fine to medium-grained rocks, in which volcanics, limestones, and conglomerates are almost completely absent, extends southeast almost to the coast of Maine.

It is possible that the Middle Ordovician rocks of northwestern Maine, some of which are associated with volcanics, were deposited in a belt extending from the Bathurst region of New Brunswick where Middle Ordovician volcanics are known southwest to the Connecticut Valley region where the Cram Hill Formation also includes volcanics of Middle Ordovician age. To the northwest the Beauceville formation, also of Middle Ordovician age, of eastern Quebec may be a correlative.

It is notable that no well-dated marine fossils of pre-Middle or possibly Early Ordovician age have been reported from the interior portion of the northern Appalachians, that is to say, the belt which extends up the Connecticut River Valley to the Quebec boundary and then turns northeast to extend through northern Maine (northwest of Houlton) to the north-central portion of New Brunswick. It is possible that this median portion of the northern Appalachians was a site of non-deposition during Cambrian and possibly Early Ordovician times, but the poorly known nature of the pre-Silurian rocks makes it premature to reach such a conclusion at this time.

Portions of northwestern Maine were strongly affected by the Taconic orogeny which probably occurred during the Middle Ordovician to Early Silurian interval. The evidence for the Taconic orogeny in northwestern Maine is the angular unconformity (Pl. 8, Fig. 3) between rocks of Early Silurian and younger age with those of pre-Silurian age, plus the fact that the pre-Silurian rocks appear to be more highly cleaved and altered. The best available dating for the Taconic orogeny in the area studied in this report is post-Middle Ordovician and pre-Late Llandovery.

Intervening between the pre-Silurian rocks of northwestern Maine and well-dated strata of post-Ordovician age are several occurrences of volcanic rocks. These volcanic rocks, described as Lobster Mountain Volcanics, are interpreted to be of pre-Taconic, Middle, or Upper Ordovician age. No diagnostic fossils have been found in association with these volcanic rocks. The rocks are interpreted as constituting a variety of pre-Taconic volcanics, possibly extruded under subaerial rather than submarine conditions as suggested by the almost total lack of marine fossils in the pyroclastics, and predating the initial incursion of the seas in post-Ordovician time.

Unconformably overlying the Lobster Mountain Volcanics are the red beds of the Big Claw Member of the Lobster Lake Formation, of Silurian age. 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 is interpreted as a non-marine unit, deposited under oxidizing conditions as evidenced by its content of specular hematite, deposited unconformably upon the older units.

The patchy distribution of the Lobster Mountain Volcanics and the strata of the Big Claw Member suggests that either they were formerly more extensive and were subsequently removed in most places by later Silurian and younger erosion, or that their original distribution was very scattered. Of these two hypotheses the writers prefer the concept of their having had an originally scattered distribution. These rocks are interpreted to represent scattered occurrences of pre-Taconic volcanic and post-Taconic non-marine rocks, possibly deposited in a number of disconnected basins of deposition.

The first well-dated Silurian rocks in this region are of Late Llandovery age and include the strata present in the Kennebago Lake quadrangle and the lime-silicate hornfels in Somerset County and part of the Silurian undifferentiated in Piscataquis County. The southeastern margin of the Moose River synclinorium is bordered by strata, predominantly calcareous phyllite and slate of probable Silurian age but it is not known whether these beds are of Early or Late Silurian age or both. No fossiliferous rocks of pre-Ludlow age have been recognized in the northwesternmost portion of Maine, or bordering the area of basement complex. The absence of pre-Ludlow age rocks in northwesternmost Maine can be explained in several ways. It is possible that they are present but unrecognized, that they were originally present but were removed by erosion subsequent to Ludlow time, or that they were never deposited in the region. Regional evidence suggests that the last possibility is the correct one.

The Ludlow and Pridoli age rocks of northern Somerset and adjacent portions of Piscataquis Counties consist mainly of calcareous siltstone, calcareous slate, and calcareous sandstone in addition to smaller amounts of limestone conglomerate and limestone. These rocks have been assigned to the Hardwood Mountain and Lobster Lake Formations. In addition to these calcareous rocks, which are well dated by means of fossils, the Hobbstown Formation of Lower Devonian age, resting unconformably upon the Hardwood Mountain Formation, occurs in the area of basement complex. The Hobbstown Formation consists almost entirely of coarse clastic debris derived from the associated basement complex, plus a minor amount of calcareous rock from the Hardwood Mountain Formation and felsitic rocks from older volcanics.

The calcareous Ludlow and Pridoli age rocks contain coarse granitic debris in their basal parts in the area bordering the eastern portion of the basement complex.

The basal clastic rocks of the eastern exposures of Hardwood Mountain Formation suggest a local source area, i.e., Somerset Island. It is concluded that the Ludlow and Pridoli age rocks of northwestern Maine were deposited, for the most part, in a relatively shallow environment favorable to the growth of stromatoporoids and corals, in which were present a number of local sources of fine to medium-grained terrigenous material, as well as a few island sources of coarse granitic debris.

The older Early Devonian is known only from a few scattered occurrences in northwestern Maine.

The Beck Pond Limestone, of Late Helderberg age, in Somerset County occurs as a very restricted patch resting on the basement complex, and containing material derived from it in the form of quartz and feldspar grains plus pebbles and cobbles of granitic rocks. Part of the Beck Pond Limestone is relatively pure, containing less than a few percent of very fine-grained terrigenous material, and consists largely of stromatoporoidal debris plus a few tetracorals. It is suggested that the pure limestone represents a relatively isolated patch of high ground, occupied by stromatoporoids for the most part, surrounding which was an area abundantly supplied with granitic debris derived from the associated basement complex. The Bear Pond Limestone Member of the Seboomook Formation, also of Late Helderberg age, presents the same problem as the less pure phases of the Beck Pond Limestone.

The interbedded tuff and limestone of the Parker Bog Formation is also of Late Helderberg age. The Parker Bog Formation records the presence of vulcanism, which resulted in the extrusion of andesitic ash which was deposited in marine waters. The vulcanism was intermittent as suggested by the numerous thin interbeds of limestone. The total thickness of the unit is several hundred feet and the average thickness of the combined limestone-felsite layers is seldom more than a few feet which suggests that a hundred or more separate ash falls are recorded. Vulcanism of this age has not been positively identified elsewhere locally except near The Forks. The Parker Bog Formation might be nearly contemporaneous with the volcanics of Helderberg age in Aroostook County (Boucot, *et al.*, 1964). No volcanic detritus has been found in association with the Beck Pond Limestone, but the large quantity of granitic debris might have tended to mask such detritus if it were present in only small amounts. Its inferred topographic position (Boucot, Harper, Rhea, 1966) in a turbulent region might have been unfavorable for the retention of fine-grained ash. The complete absence of granitic debris from the Parker Bog Formation suggests that it was not immediately adjacent to the sources of coarse debris which supplied the Hobbstown Formation plus parts of the Hardwood Mountain, Beck Pond, Bear Pond, and Tarratine.

There is abundant evidence for a major discontinuity in many places at the base of units of Oriskany age. Local unconformities of this age are present at many places around the periphery of the basement complex area, and form a large part of the evidence bearing on the existence of Somerset Island.

Throughout northwestern Maine there is an accumulation of evidence which points towards the existence of a regional unconformity at the base of the units of Oriskany and Late Helderberg age. In Somerset County the actual unconformable contact of units of Oriskany age with underlying strata of Tonoloway (Hardwood Mountain Formation) and possible Precambrian and Ordovician (basement complex) age has been observed.

The present, patchy distribution of the Helderberg and Silurian units does suggest that significant erosion of pre-Oriskany strata took place at this time, but whether this postulated erosion took place under submarine or subaerial conditions is unknown. The rarity of known lower Paleozoic non-marine deposits in northwestern Maine suggests, in any event, that the eroded material may have been redeposited under marine conditions.

ORISKANY AGE HISTORY

More adequate information is available in northwestern Maine regarding the history and genesis of the strata of Oriskany age than those of any other Paleozoic unit. The strata of Oriskany age in northwestern Maine are currently assigned to the Tarratine, Hobbstown, and Seboomook Formations. The Seboomook Formation in northwestern Maine is chiefly of Oriskany age as indicated by the fossils recovered (only two Late Helderberg occurrences are known).

Major Facies Relationships

The two most common rock types in northwestern Maine known to occur with fossils of Oriskany age are cyclicly banded slate (Seboomook Formation) and dark sandstone (Tarratine Formation).

Any discussion of strata of Oriskany age in northwestern Maine should take into consideration the following questions:

1. Source of the sediment now incorporated in the strata.
2. Means of transportation affecting the sediment between its source area and the site of deposition.
3. Conditions under which deposition took place.

SOURCE OF THE SEDIMENT NOW INCORPORATED IN THE STRATA OF ORISKANY AGE

After having assumed that a major portion of the Seboomook Formation is of Oriskany age, as indicated by the rare fossils found in association, plus the fact that the Seboomook Formation is more widely distributed than any other unit of this age one is faced with the fact that consideration of strata of Oriskany age in this region becomes perforce consideration in large part of the Seboomook Formation.

Dark sandstone of Oriskany age, except for that which is interlayered with the slate of the Seboomook Formation is restricted in its occurrence. The known areal extent of these patches of dark sandstone is relatively unimportant as contrasted with the associated cyclicly banded slate.

The foregoing discussion has omitted any reference to stratigraphic thicknesses. The available information regarding the Seboomook suggests that a minimum thickness of about twenty thousand feet is in order whereas an average thickness for the dark sandstone of the Tarratine Formation is about five to six thousand feet.

Consideration should be given as to how much of the sediment making up the rocks of Oriskany age in northwestern Maine could have been derived from the continental mass, i.e., the Canadian Shield, to the northwest. The presence of a belt of calcareous rocks northwest of the exposures of Seboomook Formation, plus the inference that a belt of shelf type rocks lay to the northwest of the calcareous rocks must be considered in connection with the problem of deriving material from the continental mass (Boucot and Johnson, 1967). The dark sandstone of the Seboomook Formation consists largely of medium to fine-grained, angular grains of quartz whereas the detrital quartz grains found in the rocks of the calcareous belt and those in the one occurrence of shelf type rocks are well-rounded to subrounded. This information regarding the rounding of the quartz grains excludes the possibility that much detrital quartz could have been derived from the continent as it is unreasonable to derive angular quartz grains from the continent when the rocks of about the same age in an intermediate position are characterized by non-angular grains. The Seboomook Formation contains no more than a few percent of calcareous material which strongly suggests that either very little calcareous material was derived from the northwest or that such calcareous material was dissolved before diagenesis had been completed. It is possible, however, that clay size material could have been derived from the northwest, although the far greater percentage of such material associated with the Seboomook Formation as contrasted with the rocks of the calcareous belt would suggest that such clay size material was not derived in large amount from the northwest.

Therefore, one is reduced to consideration of non-Shield sources for the major part of the sediment making up the Seboomook Formation. It has been previously estimated that a reasonable stratigraphic thickness for the Seboomook Formation in this region is a minimum of about twenty thousand feet. Fossils of Early Devonian age only have been recovered from this part of northern Maine. It is probable that the bulk of the total thickness of the Seboomook thickness, let us assume at least ten thousand feet, represents Oriskany time. The wide outcrop area of the unit in northern Maine alone, largely uninterrupted by anticlinal structures bringing older units to the surface or synclinal structures including younger units, suggests that the intricately folded Seboomook is very thick.

The problem can now be restated; from where can a minimum stratigraphic thickness of at least ten thousand feet of Seboomook Formation of Oriskany age have been derived. It is obvious that small features like Somerset Island are incapable of supplying such a vast volume of sediment, or that the scattered volcanic centers of Early Devonian age could provide an adequate supply of sediment.

It is concluded that the terrigenous debris of the Seboomook must have been derived from one or more large land areas situated well away from the Shield, or that a transportation mechanism and suitable path for transporting terrigenous debris over a very great distance from parts of the Shield subject to subaerial erosion existed.

The Tarratine Formation can be thought of as a deposit of sand, derived locally from older islands of basement complex and volcanic type in which mechanical breakdown to sand size had taken place, and from which some sediment was intermittently supplied to the Seboomook Formation.

CONDITIONS OF DEPOSITION

The Tarratine Formation was probably deposited in relatively shallow, near shore conditions as indicated by its shelly, benthonic fauna of brachiopods, and molluscs, together with a small representation of other groups, plus the proximity to Somerset Island. The Seboomook Formation on the other hand was deposited under conditions in which a shelly, benthonic fauna was not present. The lithology of the Seboomook does not suggest that it represents anything but a normal marine environment insofar as amount of sulfide, phosphate or the oxidation state of the iron is concerned. The absence of a shelly, benthonic fauna may be most easily explained as due to a deep water environment of deposition which was below the normal bathymetric limits for the fauna associated with the Tarratine Formation. The lack of a shelly, benthonic fauna in the absence of any evidence which would suggest that abnormal environmental conditions were prevalent in the region of Seboomook sedimentation, suggests that if a deep water environment is indicated there was no shelly benthonic bathyal fauna during the Early Devonian. The small amount of calcium carbonate in the Seboomook Formation is consistent with the hypothesis that the unit may have been deposited in deep, cold waters, although the rate of sedimentation may have been great enough to have largely masked the calcium carbonate so as to give a false impression of whether or not the environment was favorable for the preservation of calcium carbonate. With few exceptions the few fossils found associated with the Seboomook Formation occur only a few miles or less removed from the borders of the areas occupied by the Tarratine Formation. Most of these exceptions consist of isolated, lone valves of *Leptocoelia* which could well have been transported in by turbidity currents. The locality previously described on the south east shore of Gero Island in Chesuncook Lake, Piscataquis County (Boucot, 1954, p. 148) is wholly

within the area of Seboomook Formation but regional considerations suggest that the anticlinal crest, to the south of which the locality is situated, may have been occupied by dark sandstone associated with that of the Telos Lake area.

GENESIS OF THE TARRATINE FORMATION

The major facies relationships existing between the strata of Oriskany age in northwestern Maine have been considered and now the facies relations existing within the Tarratine Formation will be taken up, and discussed together with other problems bearing on the genesis of the Formation.

Facies Relationships

The Tarratine Formation consists largely of dark sandstone, but within the Formation several lithologic units can be distinguished and a certain amount of relatively systematic variation in lithology documented.

The basal McKenney Ponds Limestone Member of the Formation consists of a laterally restricted lentil of impure limestone plus minor amounts of other rock types which grade laterally into typical dark sandstone of the Tarratine Formation. The upper contact of the McKenney Ponds Limestone Member is sharp at one locality and gradational at others. The Tarratine Formation in adjacent areas consists largely of interbedded dark sandstone and slate which rest on the same basement complex as does the McKenney Ponds Limestone Member.

The Misery Quartzite Member occurring in the upper, but not uppermost, portion of the Formation is actually an interval in which there occur a number of closely spaced lentils of relatively pure quartzite. The Misery Quartzite Member is absent, due to change in facies accompanied by thinning, northeast of Big Duck Cove on the southeast side of the Moose River synclinorium, southwest of Enchanted Pond on the southeast side of the Moose River synclinorium, and northeast of Parlin Stream on the northwest side of the Moose River synclinorium, as well as in the northwest portion of the Roach River synclinorium. Both the upper and lower limits of the Misery Quartzite Member have gradational relationships with the main part of the Tarratine Formation. The main part of the Tarratine Formation in the Enchanted Pond area consists of very massive, thick beds whereas elsewhere the main body is more thinly bedded. This distinction between massive and thinly bedded dark sandstone was not mapped because of the difficulty of determining lithologic boundaries based on the distinction.

The Tarratine Formation grades basally and laterally into the Seboomook Formation in the southwestern part of the Moose River synclinorium. The zone of transition is usually at least several hundred feet thick. An arbitrary boundary has been drawn between the two Formations on the basis of the point where the exposures consist of fifty percent or more of dark sandstone being assigned to the Tarratine Formation and the reverse being assigned to the Seboomook Formation. The Tarratine Formation adjacent to the Seboomook Formation is noticeably more thinly bedded and contains a larger percentage of slate interbeds than are commonly associated with the Formation. The Tarratine Formation grades laterally into the Seboomook Formation in the northeast and northwest portions of the Moose River synclinorium. The transition from Tarratine to Seboomook is very rapid and is accomplished in less than a few miles. East of Norcross Mountain the Tarratine Formation is replaced by the Seboomook Formation in a distance of about two miles parallel to strike. From Big Duck Cove to Moose Brook Island the Tarratine Formation thins from about eight thousand feet to fifteen hundred feet or less in a distance across strike of less than three miles with an accompanying introduction of Seboomook Formation. It is possible that the Oriskany age lentil mapped as Hobbstown Formation on the west end of Bean Brook Mountain is of Tarratine age and might be alternatively interpreted as another basal lentil of the Tarratine Formation. Similar relationships between the Tarratine and Seboomook are present in the Roach River synclinorium.

Thickness

The isopach map (Plate 19) of the Tarratine Formation shows the presence of several elliptical, northeast-southwest trending bodies. Maxima of eight thousand or more feet are present in the Enchanted Pond, Norcross Mountain, and Big Spencer Mountain areas which suggests that these areas received the greatest amount of sediment. The area between the maxima contains from three to six thousand feet on the average, and peripherally away from the maxima near Enchanted Pond is also the site where the thickest individual beds have been observed in the Tarratine Formation.

All the available geologic evidence suggests that the Tarratine Formation never extended far beyond its present area of outcrop.

Lithologic Types Present

The common sedimentary rocks present, in the order of their abundance are: dark sandstone, slate, pyritic dark sandstone, and quartzite. Limestone and the calcareous dark sandstone composed largely of shell debris are relatively subordinate. The dark sandstone contains well-sorted, angular quartz grains plus grains of slate and feldspar or felsite set in a groundmass of clay-size particles. The angular quartz fragments suggest that older unconsolidated sedimentary rocks were not extensively reworked to form the dark sandstone. The slate is fine-grained and contains many bands of dark sandstone which show graded bedding. The pyritic dark sandstone resembles the non-pyritic dark sandstone in all respects except that it contains minor amounts of iron sulfide and carbonaceous material. The

quartzite consists almost entirely of angular quartz grains, well sorted for the most part.

Faunas

With a few exceptions, the fossils occur either in shell beds or as isolated valves scattered on bedding planes. These beds probably contain assemblages largely combined after death by various physical agencies as suggested by Boucot (1953). However, the lack of abrasion shown by most specimens indicates that few of the shells were transported for great distances. Such faunal assemblages are relatively useless for detailed paleoecologic study.

Bivalves, predominantly brachiopods, form the bulk of the fauna. In addition, a few gastropods, pelecypods, trilobites, and worm tubes are present. Corals are contained in abundance only in the clastic limestone of the McKenney Ponds Limestone Member. Macerated plant remains are present in a few dark sandstone beds.

Little can be concluded from this fauna about the marine environment in which it existed. However, recent brachiopods occur most commonly in waters less than 100 fathoms deep.

The locally arenophile *Mutationella* Community is more closely associated with the margins of Somerset Island and the area northwest of Norcross Mountain which corresponds with the second thickness maxima of the Tarratine Formation than is the locally argillophile *Beachia* Community. The arenaceous and argillaceous affinities of these two faunas, as suggested by the rocks with which they are associated are not absolute in the sense that the constituents of the two faunas are never found in rock types usually associated with the other. In general, however, the *Mutationella* Community does occur in the upper, less argillaceous portions of the Formation whereas the *Beachia* Community occurs more abundantly in the lower, more argillaceous portions. The *Globithyris* Community is almost entirely restricted to the rusty-weathering strata which occur above the horizon of the Misery Quartzite Member.

The rarity with which elements of the three brachiopod communities are found mixed, strongly suggest that they reflect an environmental factor. The *Beachia* and *Mutationella* Communities are mixed at a few localities, and the *Mutationella* Community does occur mixed with the *Globithyris* Community at a few localities, but the *Beachia* and *Globithyris* Communities have never been found mixed. The foregoing suggests that the conditions favorable to the *Beachia* Community were never gradational with those favorable to the *Globithyris* Community. The shallow water Big Shell Community of the McKenney Ponds Limestone Member is consistent with these data.

Interpretation

The location of the thickness maxima, one of which is adjacent to Somerset Island, strongly suggests their proximity to two local source areas. The southwestern source area is inferred to have been Somerset Island whereas the northeastern source area is inferred to have been the general environs now occupied by the Lobster Mountain Volcanics. The fact that the maxima to the southwest is correlated with the occurrence of less argillaceous material and thicker, beds tends to support this hypothesis. The *Mutationella* Community and the single Big Shell Community occurrences are more closely tied spatially to the two source areas which suggests that these two Communities existed in more near shore conditions than the contemporaneous *Beachia* Community which is more abundant in less arenaceous strata situated away from the two thickness maxima. The *Beachia* Community is inferred to have existed under conditions which favored the deposition of more argillitic material further away from shore or possibly in deeper water. The occurrence of the *Beachia* Community in the Seboomook Formation suggests that the fauna may have existed in deeper waters fringing the shallower areas which were more favorable to the *Mutationella* Community. The southwesternmost occurrence of Tarratine Formation in the Roach River synclinorium may reflect the occurrence of still a third source area to the southeast.

The relatively thin McKenney Ponds Member contains some conglomerate and arkose that were derived locally from the underlying basement complex and Lobster Mountain Volcanics, thus indicating a near-shore source area of moderate relief. The occurrence of clastic limestone indicates that the rate of deposition of terrigenous material was relatively slow; otherwise the shell debris would have been masked by the great influx of sediment, as is the case laterally in the main part of the Tarratine Formation. The Big Shell Community brachiopods, gastropods, and tabulate corals suggest a shallow-water, near-shore environment. The occurrence of some of these fossils in the basal conglomerate and arkose in a relatively unabraded condition indicates that they lived within a short distance of the shore line.

The gradational lateral relations of the Tarratine Formation with the cyclicly banded strata of the Seboomook Formation indicates that the environment in which the latter was deposited graded into that in which the former was deposited. The lithologic gradation is further supported by the faunal similarities between adjacent portions of the Tarratine and Seboomook Formations.

The beds of the main part of the Tarratine Formation consist mainly of fine- to medium-grained dark sandstone. The grains of quartz are well sorted and angular. Interbeds of argillaceous material (slate) rarely comprise more than 10 to 15 percent of any one outcrop. Individual beds have thicknesses between fractions of an inch and 50 feet. Most beds pinch out along strike in a matter of a few hundred feet, and none persists for more than a few miles.

Cross-bedding is common among the sandstones, but pseudo-nodules and ripple marks are rare. Shell beds are found in places, although their distribution is apt to be erratic. Mud cracks or raindrop impressions have not been observed. These facts lead one to the conclusion that the Tarratine Formation was deposited in an environment swept by currents, having enough relief in a few localities to permit the formation of pseudo-nodules by slumping, and permitting the growth of a fauna of brachiopods, pelecypods, and gastropods which seem adapted for life in a relatively shallow environment.

The quartzite of the Misery Quartzite Member is medium to coarse-grained, well-sorted, rarely conglomeratic, frequently cross-bedded, and massive. It occurs in beds which seldom are more than ten feet in thickness or less than one, and are interbedded with slate. No fossils have been found in it. The angular nature of the quartz grains is similar to that of the dark sandstone forming the main part of the Tarratine Formation. Interbeds of red slate and hematite-rich conglomerate are present, which suggests that some of the strata were laid down under oxidizing conditions. This quartzite may represent originally argillaceous sands from which the fine-grained material has been winnowed out during an interval when argillaceous sands were not being actively supplied to all of the region. This interpretation is further supported by the lense-like nature of the beds, and their total absence over short stretches of outcrop.

The Misery Quartzite Member, which is present in the upper portion of the Tarratine Formation, is inferred to represent an interval when sediment was not being rapidly and continuously supplied from the source areas as had previously been the case. The Misery Quartzite interval was a time when the previously deposited argillaceous sands were being reworked and the fine-grained constituents removed. Southwest of Enchanted Pond, however, it is inferred that sediment was still being rapidly supplied from Somerset Island as was also the case over most of the area northwest and southeast of the area underlain by the Lobster Mountain Volcanics. The supply of sediment was insufficient to do more than supply the areas immediately to the northwest and southeast of the Lobster Mountain Volcanics and southwest of Enchanted Pond. The absence of the Misery Quartzite on the northwest limb of the Moose River synclinorium is inferred to be due to the transition from Tarratine to Seboomook environments in which reworking of the Tarratine type sediment with consequent removal of the fines did not occur.

The *Globithyris* Community which commonly is found in strata that overlie the Misery Quartzite in rusty-weathering, sulfide rich beds suggests that after Misery Quartzite time the removal of fine-grained material ceased and that an environment more favorable to the accumulation of sulfide rich, more carbonaceous, strata in which life assemblages are more abundant, became wide-spread. The limited number of brachiopod species occurring in the *Globithyris* Community suggests that it represents conditions unfavorable for the existence of the wide variety of species found in both the *Mutationella* and *Beachia* Communities. The relative abundance of probable life assemblages suggests that current activity was not nearly as important a factor as during the deposition of the strata containing the other two faunas lower in the Tarratine section.

In summary, the Tarratine Formation is viewed as a unit made up of argillaceous sands which accumulated adjacent to two local source areas. The more quartz rich strata contain the *Mutationella* Community occurring in shallower water. The more argillaceous strata accumulated in deeper waters transitional to the areas of cyclicly banded strata and is characterized by the *Beachia* Community. In late Tarratine time the two local source areas provided insufficient debris, except in their immediate environs, for further strata to develop. Most of the area was either subject to reworking by currents which removed the bulk of the argillitic and fine-grained material, forming the Misery Quartzite Member. In deeper water, there was minor deposition which was transitional to the cyclicly banded strata. In this area, there was no reworking of the sediments. The final event in Tarratine time was the deposition of a thin veneer of locally derived material. This thin layer was deposited in a reducing, sulphide-rich environment. This environment was unfavorable to the development of most Early Devonian brachiopod species except for those of the *Globithyris* Community.

SCHOHARIE AGE HISTORY

Genesis of the Tomhegan Formation

Major Facies Relationships

The Tomhegan contains two major facies, which have not been separated on the geologic map — a northwestern facies which is predominantly non-rusty-weathering and a southeastern facies which is predominantly rusty-weathering. There is also a basal member, The Kineo Volcanic Member.

Structural complexities within the main part of the Tomhegan Formation have made detailed interpretation of the facies relationships very difficult. The broad outlines of these relationships, however, have been established.

The basal volcanic unit, the Kineo Volcanic Member, occurs in scattered outcrop areas. The volcanics are absent in more than one-half of the area covered by the basal Tomhegan formation. The thickness and lithology of the volcanics is variable from one locality to another; volcanics being absent

over more than one-half of the basal portion of the Formation. The geologic map suggests that these scattered volcanics are actually facies of the Tomhegan Formation; but it is also possible that the volcanics occur as scattered lentils sandwiched between the Tarratine Formation and the main part of the Formation. These lentils may have been partly eroded to provide volcanic debris which was incorporated in the Tomhegan Formation. The felsite conglomerate on the northwest side of Eagle Mountain may be evidence of this eroded material. It is not possible in this paper with the information available, to determine the detailed stratigraphic sequence which is represented by the Kineo Volcanic Member. Therefore, the description of the unit has been simplified; and all the volcanics are treated as one unit. It was not possible, for example, to determine whether some of the sandstone of the Tomhegan Formation, in which the sand grains were largely made up of felsite grains, is contemporaneous with the Kineo Volcanic Member or much younger because of the absence of adequate paleontologic controls.

Thickness

The thickness of the Kineo Volcanic Member ranges from a feather edge to 3,000 feet, and that of the overlying main part of the Tomhegan Formation to about 6,000 feet. The upper limits of the Tomhegan are unknown due to erosion, so it is possible that the original thickness was several times that of the remnant preserved in Somerset and Piscataquis Counties.

Faunas

The few fossils that have been found in the Kineo Volcanic Member reveal nothing about the genesis of the sediments that entombed them, other than that some of the material had been badly broken and abraded before deposition. It is possible that the Kineo was deposited entirely under subaerial conditions because of the nature of the volcanic rocks.

The main part of the Tomhegan, on the other hand, contains two distinct Communities that afford some evidence concerning the conditions of sedimentation. The Community characterized by *Amphigenia,* restricted to the northwest side of the Moose River synclinorium, contains abundant brachiopods (many species), some pelecypods, and a few gastropods, trilobites, corals, and bryozoans. That characterized by *Globithyris,* commonly restricted to the southeast side of the synclinorium, contains only one genus of brachiopod, plus additional molluscs and *Tentaculites.*

The Community in the gray-weathering, cross-bedded dark sandstone, characterized by *Amphigenia,* is marine. It usually occurs as death assemblages in shell beds, indicating that currents were active. Sulfides are not abundant in these beds. Faunas of this general type, containing many heavy-shelled brachiopods, may well have lived in relatively shallow water.

The Community in the rusty-weathering beds, characterized by the presence of the brachiopod *Globithyris,* in many places occurs as probable life assemblages, as shown by the abundance of articulated valves. It is probable, however, that the Community characterized by *Globithyris* can be disarticulated as easily as those characterized by *Amphigenia* or *Mutationella*; several localities are known at which a few disarticulated valves of *Globithyris* occur together with *Amphigenia* or *Mutationella.* Numerous beds have also been found which contain large numbers of well-sorted disarticulated valves of *Globithyris,* as well as a few pelecypod valves. The beds containing large numbers of disarticulated globithyrids are commonly not as rusty-weathering or as dark-colored (some are light quartzites) as those containing articulated shells.

Interpretation

The Kineo Volcanic Member is a volcanic facies occurring at the base of the Tomhegan Formation. The abundant conglomerates, some containing boulders of sedimentary rock up to a foot in diameter, indicate that this Member was deposited under conditions of at least moderate relief. Whether the environment in which this relief was present indicates a rugged series of submarine volcanoes, or was subaerial cannot be determined on the basis of present evidence. The absence of marine faunas of *Etymothyris* zone age suggests that the area was subject to subaerial erosion during that interval. However, the rate of sinking during the period of vulcanism coincident with the formation of the Kineo Volcanic Member is unknown, as no estimate can be made of how much of the material was deposited under marine, as opposed to subaerial, conditions. Rankin (in prep.) notes that the Kineo Volcanic Member, The Heald Mountain Rhyolite, The Traveler Rhyolite, and the Soubunge rhyolite are all subaerial units.

It is concluded, in general, that beds containing articulated globithyrids were laid down in a relatively undisturbed environment, where iron sulfides were commonly abundant as evidenced by the rusty weathering as well as the actual occurrence of iron sulfides. The beds containing disarticulated globithyrids, on the other hand, tended to be deposited under conditions of greater current activity and a weaker reducing environment with the consequent deposition of less fine-grained argillaceous sediments, as evidenced by smaller concentrations of iron sulfides and a lighter color. The rarity of globithyrids in association with the contemporaneous *Amphigenia* Community indicates that some barrier may have existed to prevent the large-scale interchange of sediment between adjacent areas supporting the two faunas. Theoretically, one should expect at least some mixing of dead shells between two such adjacent areas, yet only a few isolated

valves of globithyrids have been found in all the gray-weathering beds examined, and no elements of the Community characterized by *Amphigenia* have been found in any of the beds containing a globithyrid fauna.

Barriers capable of creating such disjunct assemblages might have been formed by physical features such as offshore bars and barrier beaches, or by environmental factors such as salinity, depth, or temperature zones. It is probable that offshore bars and barrier beaches would not have been continuous for more than a few tens of miles. The sediment accompanying the *Amphigenia* Community could have passed through channels between such barriers in the near-shore area (assuming that the sediment came from a source area to the southeast). It is also conceivable that longshore currents from the southwest or the northeast and seaward of the postulated barriers could have supplied the sediment accompanying the *Amphigenia* Community. Evidence cited from the Gaspé region and western Europe (Boucot, 1963) indicates that in those regions globithyrid Communities occur interposed between marine and nonmarine strata. The actual environment in which the Globithyrid Community lived must have been somewhat different from that which the *Amphigenia* Community inhabited. The nature of this difference, or differences, is unknown; perhaps slight differences in salinity, pH, concentration of H_2S, temperature, or depth of water were controlling factors.

If the environment that the Globithyrid Community of the Tomhegan Formation inhabited was similar to that in which those of the Gaspé region and western Europe flourished, one may be justified in inferring that a shore line during the deposition of the main part of the Tomhegan lay only a few miles to the southeast of the present edge of the Moose River synclinorium. Whether or not such a shoreline would have bounded a possible source area for the sediment that makes up the main part of the Tomhegan cannot be estimated.

It is also possible that the Globithyrid Community existed in an area of relatively quiet shoal water which received sediment from the same source as did that characterized by the *Amphigenia* Community. The location of such a source is unknown but would probably be local. No evidence is available which would indicate whether or not Somerset Island was in existence at this time.

An alternate explanation of the disjunct assemblages is that the *Amphigenia* Community was removed from the area in which it lived with the *Globithyris* Community by wave and current action. However, if *Globithyris* were able to remain behind because of some attribute which affected its hydrodynamic behavior or the ease with which it was torn loose from its substrate, one might infer that the benthonic elements originally associated with it had been washed beyond it to accumulate as death assemblages and that *Globithyris* had been preserved in life assemblages by sediment that later advanced over and covered it. An implicit corollary to this suggestion, by reason of the occurrence of shell beds containing *Globithyris* alone, is that single valves of *Globithyris* have a competent velocity greater than that of the other invertebrates contained in the *Amphigenia* Community. However, the grain size of the sediment in the beds containing single valves of *Globithyris* is similar to that of the sediment containing disarticulated elements of the *Amphigenia* Community.

The probability that no elements of the *Amphigenia* Community would have been preserved together with the life assemblages characterized by *Globithyris* is low, in view of the number of such deposits examined, unless the tendency of articulated valves of *Globithyris* to remain unmoved is far greater than the competent velocity of the various elements comprising the *Amphigenia* Community. The crinoid columnals commonly associated with the *Amphigenia* Community would have had greater competent velocities than articulated globithyrids; thus there is little possibility that globithyrids would remain unmoved by currents competent to move crinoid columnals, unless the globithyrids were anchored in place after death by a very decay-resistant pedicle until buried, or lived buried in mud as does *Lingula*. At locality SD-2754 abundant articulated shells of a taxodont pelecypod (*Nuculoidea*) possessing a resilium occur as a life assemblage in association with *Globithyris*, and in the total absence of any members of the *Amphigenia* Community. This indicates that, unless *Nuculoidea* and *Globithyris* have an unusually high competent velocity, the *Amphigenia* Community was certainly not present at this one locality, where it might logically be expected if the two Communities were ever associated in life.

Circumstantial evidence bearing on this problem is the lack of abraded shells in the shell beds containing the *Amphigenia* Community. This is somewhat unexpected, if the shells in question have been transported for distances of the order of miles.

It is concluded that the *Globithyris* and *Amphigenia* Communities never occupied the same areas at the same time, although they existed in the region contemporaneously. This disjunct distribution of these Communities is inferred to be due to an ecologic factor or factors which provided two different environments.

POST-EARLY DEVONIAN HISTORY

Middle Devonian rocks of marine origin are absent in Maine and non-marine rocks are rare.

No Upper Devonian rocks are present in northwestern Maine. Evidence from elsewhere in the northern Appalachians (Bastin and Williams, 1914; Alcock(1935, p. 85-89) indicates that it was probably a time of erosion in which the mountains

formed during the Acadian orogeny were being destroyed.

In northwestern Maine the geologic record after the Early Devonian is almost non-existent. A few teschenite dikes, a few bodies of granite, and a layer of Pleistocene deposits are the surviving representatives of the geologic time that has elapsed since the close of the Early Devonian (Boucot, Griffin, Denton and Perry, 1959). The dikes can be correlated either with the Monteregian type of intrusive or with similar rocks of Triassic age. The age of the granite is probably Middle Devonian.

Since northwestern Maine is northwest of the zone of Carboniferous and Permian folding that extends through Newfoundland, Nova Scotia, southern New Brunswick, and Rhode Island, it probably was not strongly affected by the orogenies at the end of the Paleozoic.

The Problem of Shell Beds

Most of the fossils of the Moose River Group occur in shell beds. These shell beds consist of thin, lenticular layers, commonly about three inches thick and seldom exceeding six inches. They do not have any great lateral extent, usually pinching out within a few tens of feet or less. The shell beds are packed with disarticulated brachiopod shells, a few whole shells, and the remains of the other invertebrates. The shells are imbedded in a matrix, commonly composed of slate or fine-grained argillaceous sandstone. As mentioned by Perkins (1925), these shell beds usually contain what he called "clay-galls," which he thought were the fragmented remains of adjacent beds of shaly material. These "clay-galls" are rounded pebbles of dark slate which may or may not have been lithified at the time of deposition. At Long Pond and Rockwood the shell beds are associated with pseudo-nodules in adjacent beds.

Detailed examination of such shell beds in Parlin Gorge led to the conclusion that each of them probably contained a death assemblage of fossils that had been transported for at least a short distance from the place where they had lived (Boucot, 1953).

Such deposits can be seen on modern marine beaches, where windrows of shelly material have been sorted out and collected by the waves. Van Straaten (1950) has pointed out another mechanism for the formation of shell beds that may well be applicable, at least in part, to some of the deposits in the Moose River Group. He reports that "gully meanders" on tidal flats work their way through unconsolidated materials, carrying away the fine sediment while permitting the larger shells to be dropped to the bottom of the gully, where they form a shell deposit as the meander changes position. The smaller shells are deposited in similar shell beds elsewhere (Van Straaten, written communication, 1951).

All of the beds studied by Van Straaten are of shallow water origin and are at least partly exposed at low tide. On the other hand, it is inferred that most of the marine strata in the Moose River Group were deposited in somewhat deeper water because of the lack of mud cracks, raindrop impressions, and similar phenomena. However, the formation of shell beds probably takes place under conditions of submarine erosion that can produce ripple marks in the sediment in much the same manner as that observed by Van Straaten.

Luders and Trusheim (1929) describe another mechanism capable of making a shell bed under marine conditions. In certain tidal sluiceways of the Frisian Islands large ridges or ripples were observed to be capped with a layer of heavy shell debris ("Schillbedeckung"). They inferred that this coating was produced by tidal currents that removed all the small shells and mud, leaving only a capping of large shells whose competent velocities were higher than that of the currents in the sluiceway. This hypothesis was then tested in a model and found to be reproducible under conditions of current velocity like those in the tidal sluiceway. It is not felt that this mechanism produced the shell beds of the Moose River Group because of the presence of many small shells in the beds and the lack of large ripple marks.

Evidences of submarine erosion and slipping are present at two localities in Long Pond and Rockwood, where pseudo-nodules similar to those described by Macar (1948) were found. These structures, which are caused by submarine sliding, indicate submarine slopes. The presence of much cross-bedded sandstone in the area shows that erosion took place on these submarine slopes.

The shell beds in the Moose River Group were probably developed by a mechanism that operated below the level of low tide; however, present knowledge of these shell beds gives no hint of the precise nature of that mechanism.

Powers and Kinsman (1953) present evidence that shell beds of Recent age in Chesapeake Bay are formed by the sorting effect of swells in a manner analogous to the grading produced by the jiggling of a box of poorly sorted material which results in the larger particles sinking to the bottom of the box and grading up into the smaller particles on the surface of the box. The process is concluded to take place in the traction zone whose depth is governed by the amplitude of the swells. Powers and Kinsman (*idem*) concludes that this process may be an important one on the continental shelves. It is possible that the shell beds of northwestern Maine were formed largely in this manner, but unfortunately no information is available as to the extent of grading present in the shell beds or in the adjacent overlying sediment. The impression gained in the field was that grading was not present in the shell beds, but until this problem is more carefully examined in the laboratory it would be premature to arrive at any conclusions either way.

REFERENCES

Albee, A. L., and Boudette, E., Attean Quadrangle: U. S. Geol. Surv., Open File Report, 1965.

Alcock, F. J., Geology of Chaleur Bay region: Canada Dept. Mines, Bur. Econ. Geology, Geol. Survey Mem. 183, p. 146, 1935.

Bastin, E. S., and Williams, H. S., U. S. Geol. Survey Geol. Atlas, Eastport, Maine, folio (no. 192), 1914.

Boucot, A. J., Life and death assemblages among fossils: Am. Jour, Sci., vol. 251, p. 24-40, January 1953.

————., Age of the Katahdin granite: Amer. Jour. Sci., vol. 252, p. 144-148, 1954.

————., Brachiopods of the Lower Devonian rocks at Highland Mills, New York: J. Paleo, v. 33, No. 5, p. 727-769, 1959.

————., Early Devonian Ambocoeliinae (Brachiopoda): J. Paleo., v. 33, p. 16-24, 1959.

————., Stratigraphy of the Moose River synclinorium, Maine: U. S. Geol. Surv., Bull. 1111E, p. 153-188, 1961.

————., Appalachian Siluro-Devonian: in Some Aspects of the Variscan Fold Belt, Ninth inter-University Geological Congress, Manchester Univ. Press, p. 155-163, 1962.

————., The globithyrid facies of the Lower Devonian: Senck., Lethaea, v. 44, No. 1, p. 79-84, Frankfurt, 1963.

————., and Amsden, T. W., *Chonostrophiella*, a new genus of chonostrophid brachiopod: J. Paleo., v. 38, p. 881-884, 1964.

————., Brace, W., and DeMar, R., Distribution of Brachiopod and Pelecypod Shells by Currents: Jour. Sed. Pet., v. 28, p. 321-332, 1958.

————., Caster, K. E., Ives, David, and Talent, John A., Relationships of a new Lower Devonian terebratuloid (Brachiopoda) from Antarctica: Bull. Amer. Paleontology, v. 46, no. 207, p. 81-151, 1963.

————., Cummings, L. M., and Jaeger, H., Age of the Gaspé Sandstone and Gaspé Limestone: Geol. Surv. Canada, Paper 67-25, p. 1-27.

————., Field, M. T., Fletcher, R., Forbes, W. H., Naylor, R. S., and Pavlides, L., Reconnaissance Bedrock Geology of the Presque Isle quadrangle, Maine: Maine Geol. Surv., Quadrangle Mapping Series No. 2, 123 p., 1964.

————., Griffin, J. R., Denton, G. H., and Perry, P. S., The Geology of a Six-Mile section along Spencer Stream, Somerset County, Maine: Maine Geol. Surv., Special Geol. Studies Series #2, 28 p., 1959b.

————., Griscom, A., and Allingham, J. W., Geologic and Aeromagnetic Map of northern Maine: U. S. Geol. Surv., Geophysical Investigations Map GP-312, 7 p., 1964.

————., Harper, C., and Rhea, K., Geology of the Beck Pond Area, Township 3—Range 5, Somerset County, Maine: Maine Geol. Surv., Special Geol. Studies Series #1, 33 p., 1959a.

————., Harper C., and Rhea, K., New Scotland Depositional History of the Beck Pond Region, Somerset County, Maine: Maine Geol. Survey., Contrib. Geol. Maine, Bull. No. 18, p. 23-63, 1966.

————., and Johnson, J. G., Paleogeography and Correlation of Appalachian Province Lower Devonian Sedimentary rocks: Tulsa Geol. Soc. Digest, v. 35, p. 35-87, 1967.

————., and Yochelson, E. L., Paleozoic Gastropoda from the Moose River Synclinorium, northern Maine: U. S. Geol. Surv., Prof. Paper 503-A, p. A1-A20, 1966.

Brace, W. F., The geology of the Rutland area, Vermont: Vermont Geol. Surv., Bull. No. 6, 120 p., 1953.

Clarke, J. M., Some new Devonic fossils: New York State Mus. Bull. 107, Geol. 12, p. 153-291, 1907.

————., Early Devonic History of New York and Eastern North America: New York State Mus. Mem. 9, pt. 2, 1909.

Espenshade, G. H., Brachiopods put limits on extent of pre-Silurian strata: U. S. Geol. Surv., Prof. Paper 525-A, Summary of Paleontologic Investigations, p. 9, 1965.

Goldring, W. A., A new species of crinoid from the Devonian (Oriskany) of Maine: Portland Soc. Nat. Hist., v. IV, p. 153-155, 1933.

Heath, E. W., Stratigraphy and Structure of the Roach River Syncline: Unpublished M.S. thesis, M.I.T., 125 p. 1959.

Hitchcock, C. H., Preliminary Report Upon the Natural History and Geology of the State of Maine: Maine Board Agric., 6th ann. rept., p. 91-458, 1861.

————., Geology of Maine: Maine Board Agric., 7th ann. rept., pp. 223-430, 1862.

————., and Huntington, J. H., Geology of the Northwest Part of Maine: American Assoc. Advancement of Sci. Proc., vol. 22, pt. 2, p. 205-214, 1874.

Hurley, P. T., and Thompson, J. B., Jr., Airborne Magnetometer and Geological Reconnaissance in Northwestern Maine: Geol. Soc. America Bull., vol. 61, p. 835-842, 1950.

————., Boucot, A. J., Albee, A. L., Faul, H., Pinson, W. H., Fairbairn, H. W., Minimum age of the Lower Devonian slate near Jackman Maine: Bull. Geol. Soc. Amer., v. 70, p. 947-950, 1959.

Jackson, C. T., First Report on the Geology of the State of Maine: Augusta, 128 p., 1837.

Keith, A., Preliminary Geologic Map of Maine: Maine Geol. Survey, 1933.

Luders, K., and Trusheim, F., Beitrage zur Ablagerung mariner Mollusken in der Flachsee: Entstehung und Aufbrau von Grossrucken mit Schillbedeckung in Flutbezv. Ebbetrichtern der Aussenjade, Senckenbergiana, Band 11, pp. 123-141, 1929.

Macar, P., Les Pseudo-nodules du Famennien et leur origine: Soc. Geol. Belgique Annales, tome 72, p. October 1948.

Marleau, R. A., Preliminary Report on East Megantic and Armstrong Areas Electoral Districts of Frontenac and Beauce: Quebec Department of Mines, Geological Surveys Branch, P.R. No. 362, 1958.

McGerrigle, H. W., Mount Megantic Area, Southeastern Quebec, and its Placer-Gold Deposits: Quebec Bur. Mines, Ann. Rept. 1934 Pt. D, pp. 63-104, 1935.

Oliver, W. A., Jr., Devonian rugose corals from northern Maine: U. S. Geol. Surv., Bull. 1111-A, 23 p. 1960.

————., Silurian rugose corals from the Lake Temiscouata area, Quebec: U. S. Geol. Surv., Prof. Paper 430-B, p. 11-17, 1962.

Pankiwskyj, K. A., Geology of Limestone Hill, Stratton quadrangle, Somerset Co., Maine: Unpublished B.S. thesis, M.I.T., 13 p., 1959.

Perkins, E. H., Contributions to the Geology of Maine, No. 2, Pt. 1, The Moose River Sandstone and its Associated Formations: Am. Jour. Sci., vol. 10, p. 368-375, October 1925.

Pirsson, L. V., and Schuchert, C., Note on the Occurrence of the Oriskany Formation on Parlin Stream, Maine: Am. Jour. Sci., vol. 37, p. 221-224, 1914

Powers, M. C., and Kinsman, B., Shell Accumulations in Underwater Sediments and their Relations to the Thickness of the Traction Zone: Jour. Sed. Pet., vol. 23, no. 4, p. 229-234, 1953.

Rankin, D. W., Paleogeographic implications of deposits of hot ash flows: International Geol. Cong., Rpt. XXI Session, Norden, Pt. XII, Regional Paleogeography, p. 19-34, 1960.

Smith, E. S. C., The Igneous Rocks of Mt. Kineo and Vicinity: Am. Jour. Sci., vol. 10, p. 437-444, 1925.

————., A New Rhyolite from the State of Maine: Am. Jour. Sci., 5th ser., vol. 19, p. 6-8, 1930.

————., Contributions to the Geology of Maine, V: Am. Jour. Sci., vol. 25, p 225-228, March 1933

Smith, G. O., Geology, in Barrow, H. K., Water Resources of the Kennebec River Basin, Maine: U. S. Geol. Surv., Water-Supply and Irrigation Paper No. 198, p. 4-9, 1907.

Stumm, E. C., Silurian Corals from the Moose River Synclinorium, Maine: U. S. Geol. Surv., Prof. Paper 430-A, p. 1-9, 1962.

Toppan, F. M., The Geology of Maine: Master's Thesis, Dept. of Geology, Union College, Schenectady, New York, p. 141, 1932.

Van Straaten, L. M. F. U., Environment of Formation and Facies of the Wadden Sea Sediments, Part I. The Mollusc Fauna and the Distribution of Mollusc Shells in the Sediments: Waddensymposium, p. 94-108, 1950.

Whittington, H. B., and Campbell, K. S. W., 1967, Silicified Silurian Trilobites from Maine: Bulletin of the Museum of Comparative Zoology, Harvard, vol. 135, no. 9, p. 447-483, 20 pls.

Willard, B., Silurian Fossils from Ripogenus Dam, Maine: Jour. Paleontology, Vol. 19, no. 1, p. 64-68, 1945.

Williams, H. S., and Breger, C. L., The Fauna of the Chapman Sandstone of Maine: U. S. Geol. Survey Prof. Paper 89, 347 p., 1916.

Woodard, Henry, Report on the Geology of a Portion of the Spencer Lake Area, Maine: Maine State Geologist Rept. 1948-49, p. 68-77, 1950.

EXPLANATION OF PLATES 1 THROUGH 12

Plate 1

Fig. 1 — Flow breccia of the Kineo Volcanic Member (x½). Note the angular fragments of rhyolite enclosed in a matrix of the same type rhyolite on the polished surface. South ninth of North East Carry quadrangle, Piscataquis County, Maine, on north shore of Big Duck Cove, N12W from the mouth of the stream emptying into the cove.

Fig 2. — Flow breccia of the Kineo Volcanic Member. Both the "cobbles" and the matrix are composed of similar appearing felsite. Photograph taken on the northeast side of Big Duck Cove, East Middlesex Canal Grant, North East Carry quadrangle, Piscataquis County, Maine.

Plate 2

Fig. 1 — Fragment of devitrified perlite in tuffaceous conglomeratic sandstone of the Kineo Volcanic Member (x25, plane light). Note the onion-skin appearance of the perlite and the angular, sand-sized clastic grains bordering the perlite fragment. Under crossed nicols the perlitic texture is not readily apparent. SE ninth of Long Pond quadrangle, Somerset County, Maine, 0.52 mile N. 10 W. from the northeast corner of Parlin Pond township.

Fig. 2 — Flow-banded garnet rhyolite of the Kineo Volcanic Member (intrusive equivalent) (x15, plane light). Note the large phenocryst of garnet and the sinuous path of the flow lines which wrap around the garnet. The euhedral phenocrysts are largely altered feldspar. SE ninth of Long Pond quadrangle, Somerset County, Maine, on Williams Mountain, 0.35 mile S. 51 W. from the triangulation station (Elevation 2395), at an elevation of 2300 feet.

Plate 3

Fig. 1 — Spherulitic rhyolite of the Kineo Volcanic Member (x50, plane light). Note the scattered spherulites some of which contain quartzoids centrally. The spherulites are not apparent under crossed-nicols as the rock is devitrified. West ninth of Brassua Lake quadrangle, Somerset County, Maine, on stream flowing south through the "M" of "MISERY," at an elevation of 1440 feet.

Fig. 2 — Tuffaceous sandstone of the Kineo Volcanic Member (x50, plane light). Note the scattered shards of devitrified glass and the clastic quartz grains set in a groundmass of dark-colored, fine-grained material. Southwest ninth of Brassua Lake quadrangle, Somerset County, Maine, 0.82 mile S37W from the inlet of the unnamed pond on which Warren Camp is located.

Plate 4

Fig. 1 — Dark sandstone of the Tarratine Formation (x25, crossed nicols). Note the relatively well-sorted, angular clastic grains, mostly quartz, set in a fine-grained groundmass. South ninth of Long Pond quadrangle, Somerset County, Maine, 0.35 mile N. 54 E. of the point where a wagon road joins Rt. 201 near Jackman Field, at an elevation of 2020 feet.

Fig. 2 — Dark sandstone of the Tarratine Formation (x50, plane light). Note the angular, poorly sorted quartz grains set in a groundmass of fine-grained material. Southeast ninth of Long Pond quadrangle, Somerset County, Maine, on Parlin Stream (for detailed location see Plate 20).

Plate 5

Fig. 1 — Arkosic sandstone of the McKenney Ponds Limestone Member of the Tarratine Formation (x25, plane light). Note the sub-rounded, relatively well-sorted grains; clear grains are quartz and the gray grains are potash feldspar. Almost no fine-grained, interstitial material is present in this rock. Northwest ninth of Pierce Pond quadrangle, Somerset County, Maine, on the trail from the McKenney Ponds to Grace Pond, 0.14 mile northeast of the inlet of the northernmost McKenney Pond.

Fig. 2 — Dark sandstone of the Tarratine Formation (x25, polished section in reflected light). Note the abundant sand-sized grains of black slate, plus chalky grains of feldspar or felsite associated with the cloudy quartz grains. Southeast ninth of Long Pond quadrangle, Somerset County, Maine, on Parlin Stream (for detailed location see Plate 20).

Plate 6

Fig. 1 — Solution channel in McKenney Ponds Limestone Member of Tarratine Formation. Note the relatively gentle slope of the bedding from right to left.

Photograph taken in Enchanted Cave, about one-hundred yards southwest of the westernmost of the McKenney Ponds, Upper Enchanted township, Pierce Pond quadrangle, Somerset County, Maine.

Fig. 2 — Jointed basement complex with joints occupied by rounded cobbles of Hobbstown Formation which include basement complex rocks and limestone of Middle Paleozoic aspect. The filled joint is to the right of the man.

Photograph taken about one-third mile south of the dam at Baker Pond, Spencer quadrangle, Somerset County, Maine.

Fig. 3 — Close-up of conglomeratic joint filling shown in figure 2. Note the shear sides of the joint as contrasted with the rounded cobbles filling the fissure.

Plate 7

Fig. 1 — Contact between porphyritic felsite pebble and argillaceous sandstone of the Basal Conglomerate Member of the Hobbstown Formation (x25, plane light). Note the sharp contact between the pebble and the poorly sorted clastic debris. The clastic debris consists largely of angular, clear quartz grains plus mottled fragments of altered feldspar, felsite, and slate. The phenocryst in the felsite is a badly altered crystal of feldspar. On boundary between north and northeast ninths of Spencer quadrangle, Somerset County, Maine, 0.06 mile north of boundary with central and east ninths.

Fig. 2 — Arkosic sandstone of the Hobbstown Formation (x50, plane light). Note the well-sorted nature of the rock with a minimum of fine-grained material in the groundmass. The clear grains are quartz and the mottled grains are altered feldspar. None of these grains are noticeably rounded. South ninth of Long Pond quadrangle, Somerset County, Maine, on southwest end of Bean Brook Mountain, 0.72 mile N. 30 E. from the top of 2300-foot hill (near west boundary of ninth), at an elevation of 2110 feet.

Plate 8

Fig. 1 — Contact of the Big Claw Member of the Lobster Lake Formation with underlying phyllite of the Cambrian or Ordovician. The hammer spans the unconformable contact. The lowest layer of the Big Claw Member is a conglomeratic rock composed largely of phyllite and felsite fragments. Photograph taken on the southeast side of the point which marks the boundary between Big Claw and the main body of Lobster Lake, Lobster township, North East Carry quadrangle, Piscataquis County, Maine.

Fig. 2 — Pitted weathering of steeply inclined calcareous siltstone of the Lobster Lake Formation which includes limestone pebbles that have dissolved out to leave voids.

Photograph taken about three-quarters mile east of Spaulding Point, Lobster Lake, North East Carry quadrangle, Piscataquis County, Maine.

Fig. 3 — Unconformable contact of the Big Claw Member of the Lobster Lake Formation with the underlying phyllite of the Cambrian or Ordovician. The man is sitting at the contact which is marked by the white basal bed of the Big Claw Member which is inclined to the left. Note the cleavage in the foreground phyllite which trends almost at right angles to the strike of the overlying strata.

Photograph taken on the southeast side of the point which marks the boundary between Big Claw and the main body of Lobster Lake, Lobster township, North East Carry quadrangle, Piscataquis County, Maine.

Plate 9

Fig. 1 — Calcareous sandstone of the Hardwood Mountain Formation (x25, plane light). Note the extreme angularity of the clear quartz grains and the contact between the layer of more quartz rich sediment in the lower right and that containing more calcite. The quartz rich layer contains a more poorly sorted aggregate of detrital quartz grains. The gray crystals are interlocking grains of calcite. A fragmentary fossil is visible just below the middle of the picture. Northeast ninth of Spencer quadrangle, Somerset County, Maine, 0.34 mile N. 50 E. from the southwest corner of the ninth, at an elevation of 1930 feet.

Fig. 2 — Limestone conglomerate of the Hardwood Mountain Formation. Note the effects of differential solution upon the limestone pebbles and the less calcareous siltstone of the matrix in which the pebbles are set. Fossils are present in the pebbles but are uncommon in the siltstone.

North ninth of Spencer quadrangle, 0.68 mile S60W from top of 2364 foot hill (Hardwood Mountain), at an elevation of 1925 feet.

Plate 10

Fig. 1 — Cordierite hornfels of the Seboomook Formation. Note the elongate, dark-weathering cordierite crystals in a matrix of fine-grained, silvery hornfels. Shore of Wood Pond, Jackman, Somerset County, Maine.

Fig. 2 — Cordierite hornfels of the Seboomook Formation (x50, crossed nicols). Note the circular porphyroblast of cordierite filled with inclusions. The cordierite crystal is cyclicly twinned as shown by the pie-shaped sectors into which it is divided. Exposure at Bench Mark 1 mile east of Jackman on Canadian Pacific R.R., Long Pond quadrangle, W. ninth, Somerset County, Maine.

Plate 11

Fig. 1 — Fracture cleavage cutting layer of siltstone belonging to the Tomhegan Formation. Note the rippled effect that the cleavage produces on the bedding plane. Photograph taken on southeast side of Misery Stream below shack located just north of the dam on Misery Pond, Misery township, Brassua Lake quadrangle, Somerset County, Maine.

Fig. 2 — Fault contact between slate of the Hardwood Mountain Formation and granitic basement complex. Note the coarse-grained breccia found along the upper right side of the contact where brecciated granite has had slate squeezed between the granite fragments. Several fragments of granite have become detached and are isolated in the slate. Note the lack of any metamorphic effects such as the growth of porphyroblasts which would be expected along an intrusive contact. The planar features of the slate are cleavage planes which closely parallel the bedding at this exposure. Central ninth of Spencer quadrangle. Somerset County, Maine, 1.2 miles S31E from the inlet of Baker Pond.

Plate 12

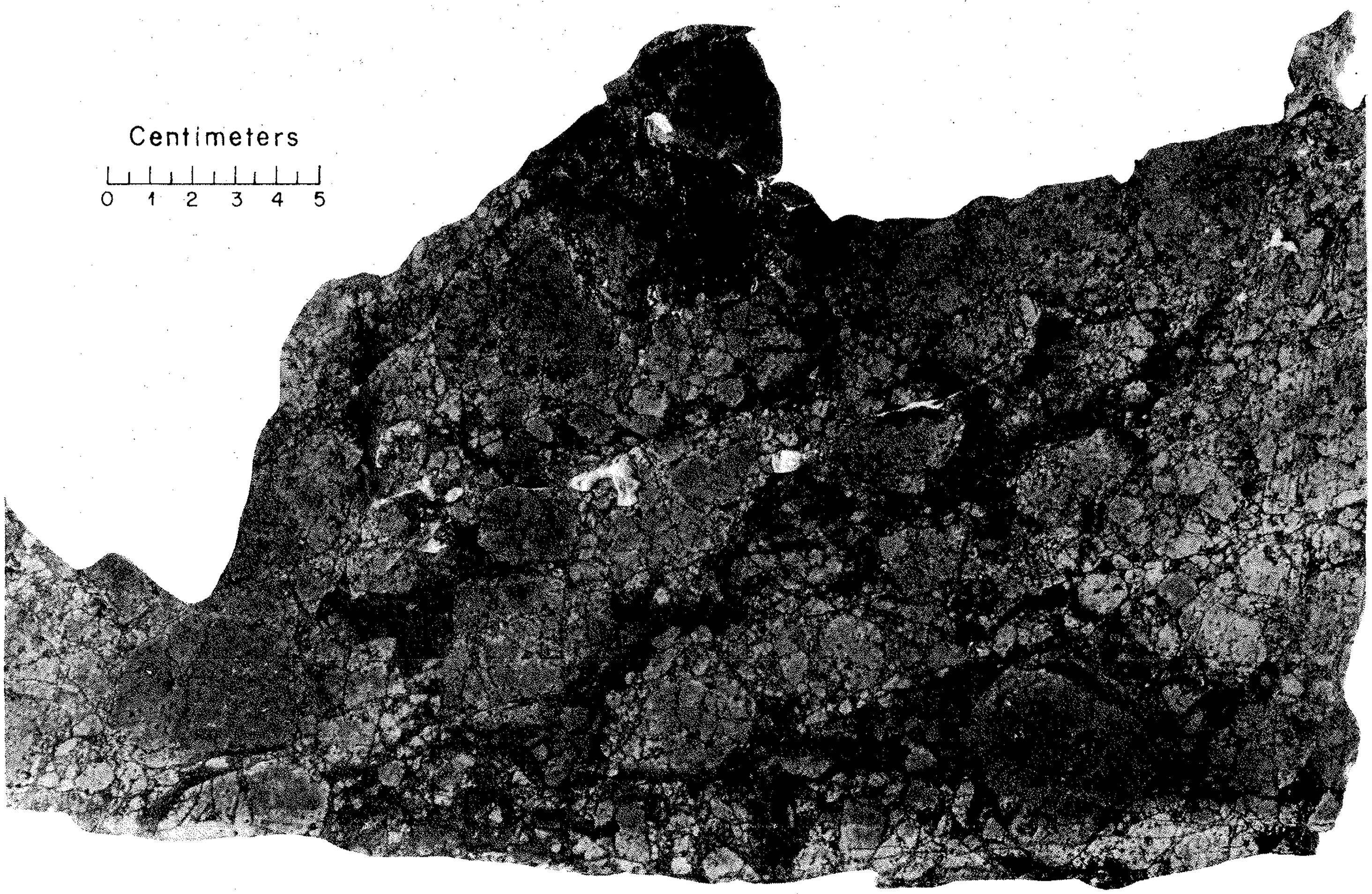
Fig 1 — Deformed strophomenoid brachiopods (*Strophonella* cf. S. *punctulifera* sp. x1) from the Parker Bog Formation. The fossils occur in felsitic rock, probably an altered andesitic tuff, and have been subjected to shear, the specimen on the left having been compressed and that on the right elongated. West ninth of Pierce Pond quadrangle, Somerset County, Maine, 0.87 mile S48E from the outlet of Heald Pond, in a swampy area just south of a small stream flowing into the Park Bog Ponds just north of the "*P*" in "*Ponds*".

Fig. 2 — Limestone conglomerate of the Silurian undifferentiated. Note the stretched pebbles possessing sharp extremities. The long axis of the specimen and the pebbles is parallel to the shear cleavage planes. Southwest ninth of Moosehead Lake quadrangle, Piscataquis County, Maine, on shore of Moosehead Lake N87W from the southernmost tip of Deer Island.

Fig. 3 — Columnarly jointed garnet rhyolite sill. Photograph taken on southeast end of Misery Pond, Misery township, Brassua Lake quadrangle, Somerset County, Maine.

THE FOLLOWING PHOTOGRAPHIC SECTION

SHOWS PLATES 1–12



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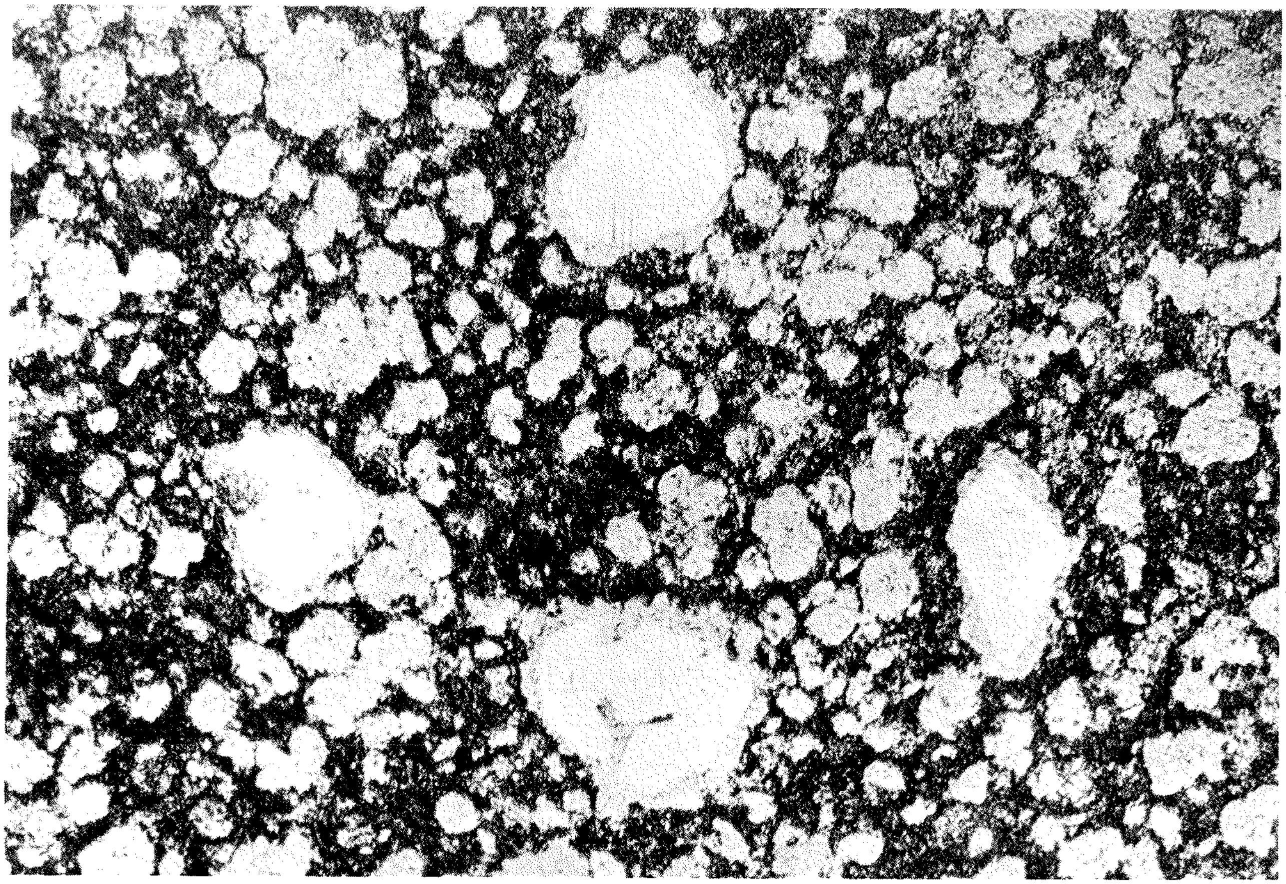

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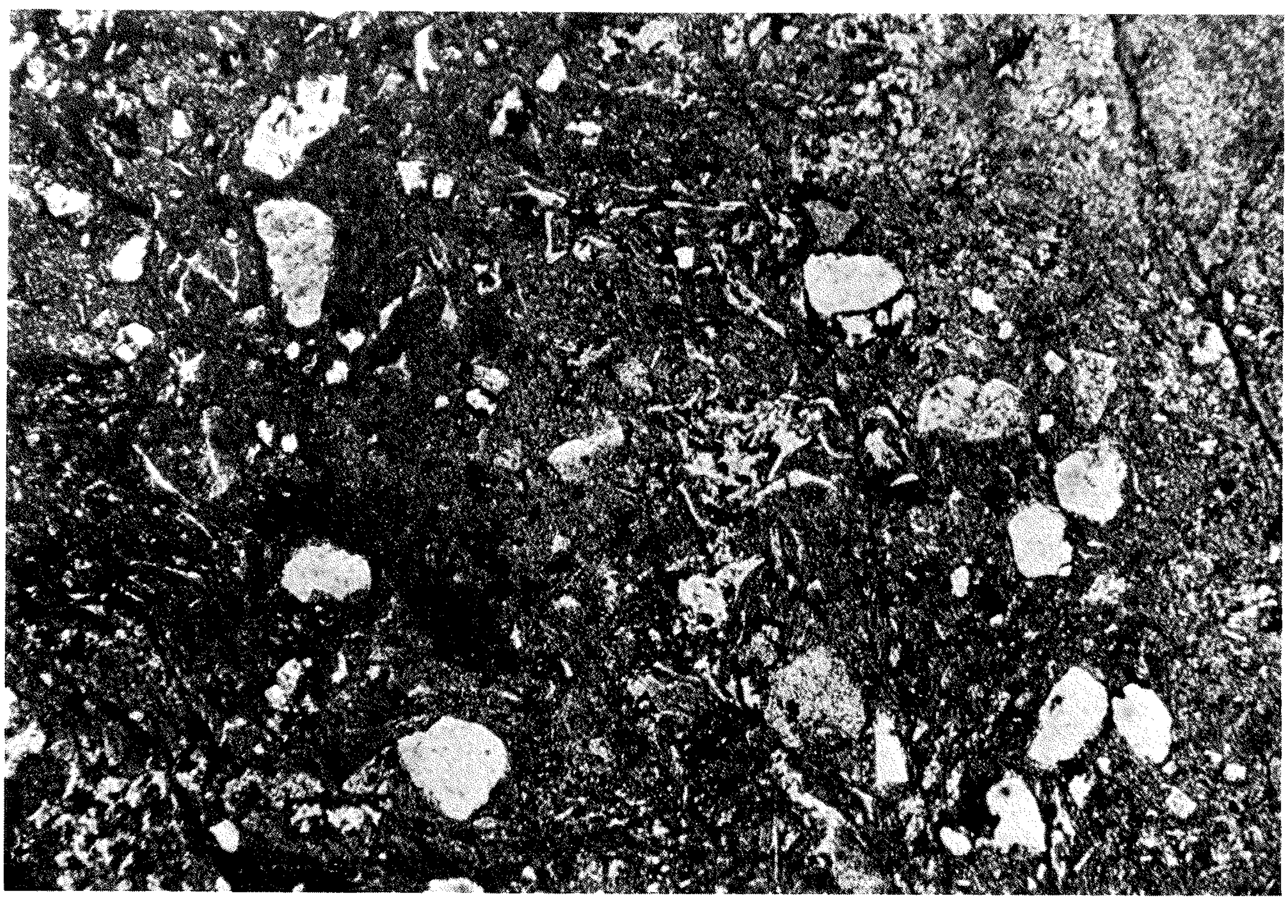

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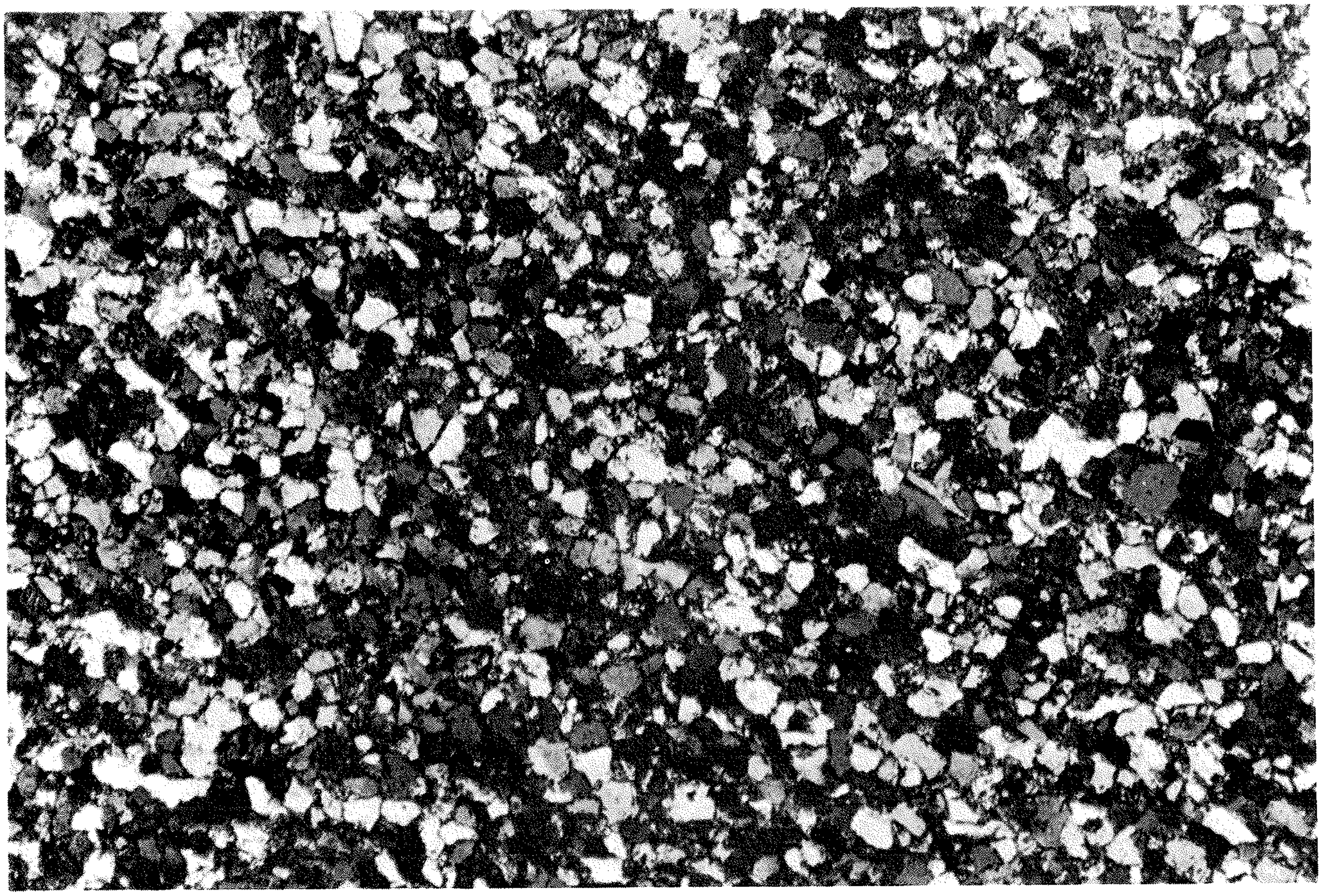

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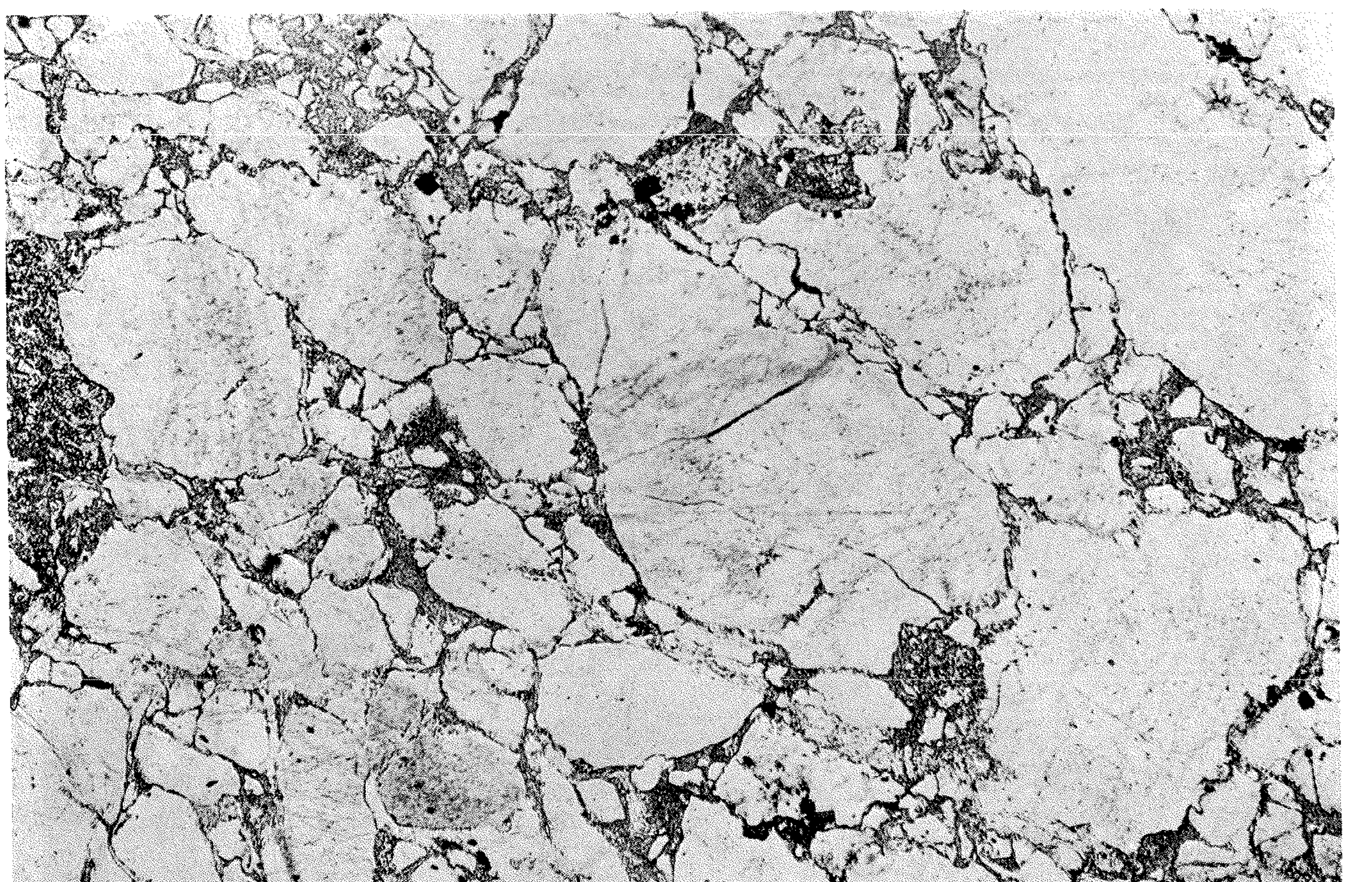

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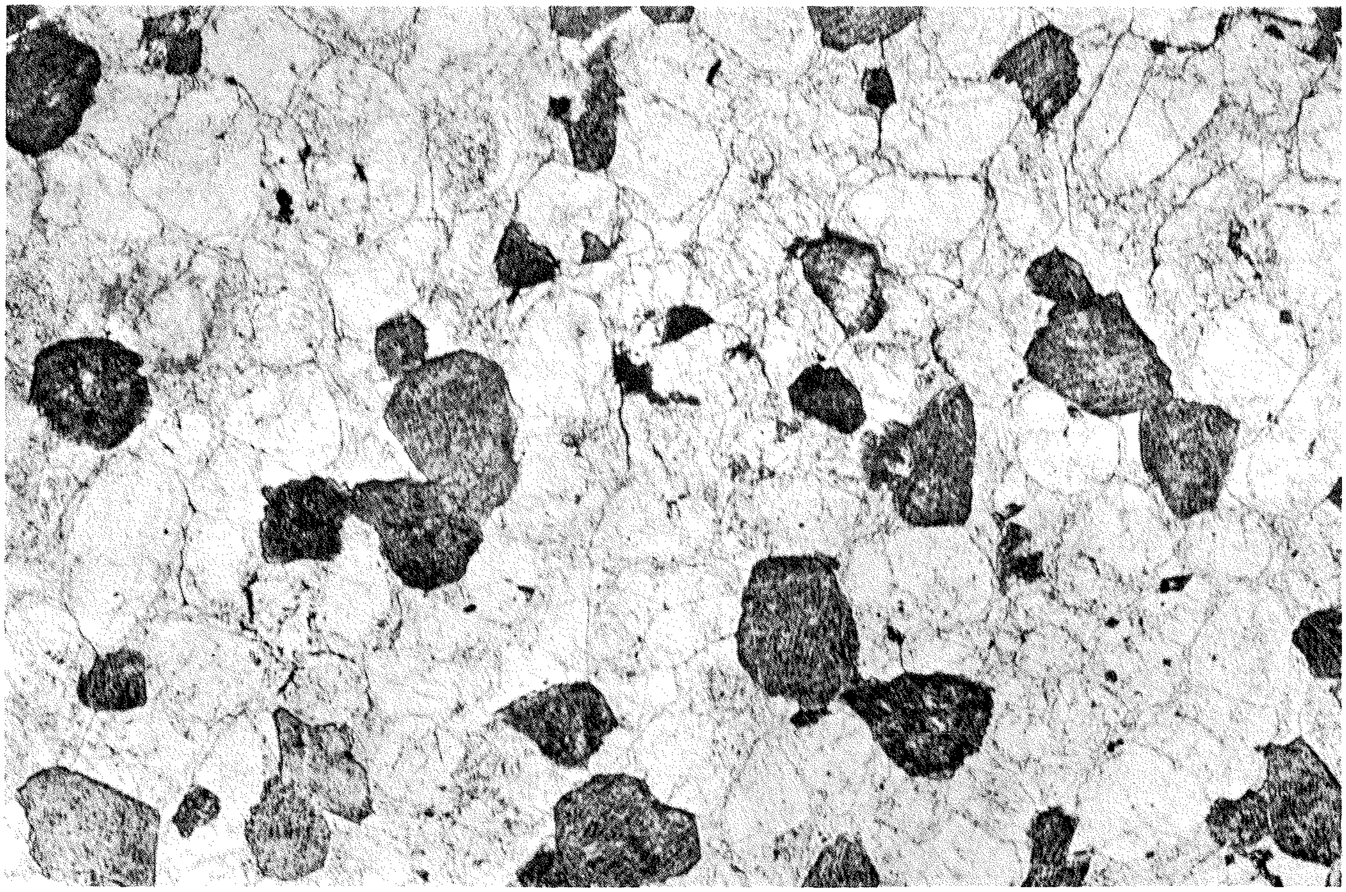

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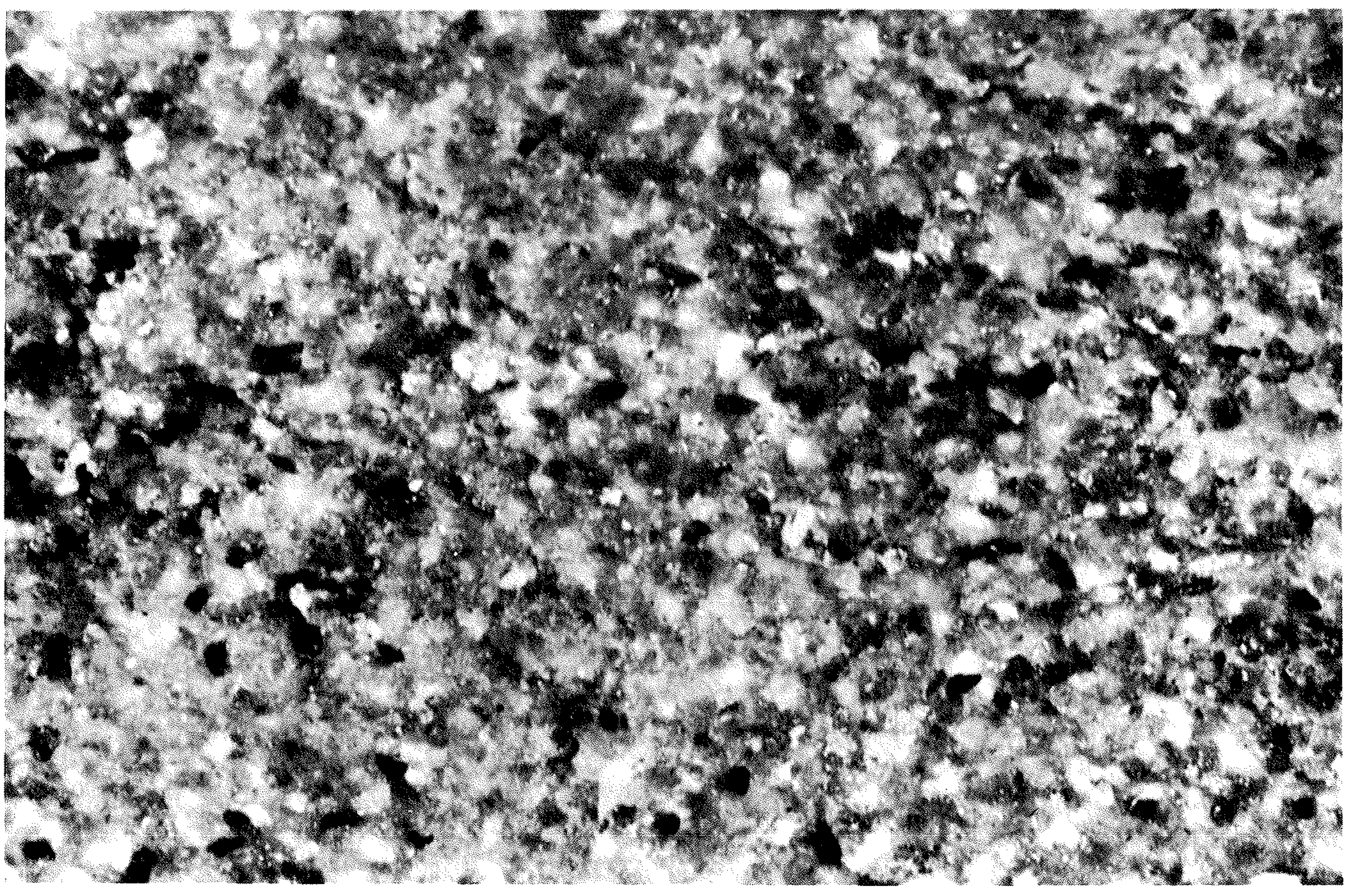

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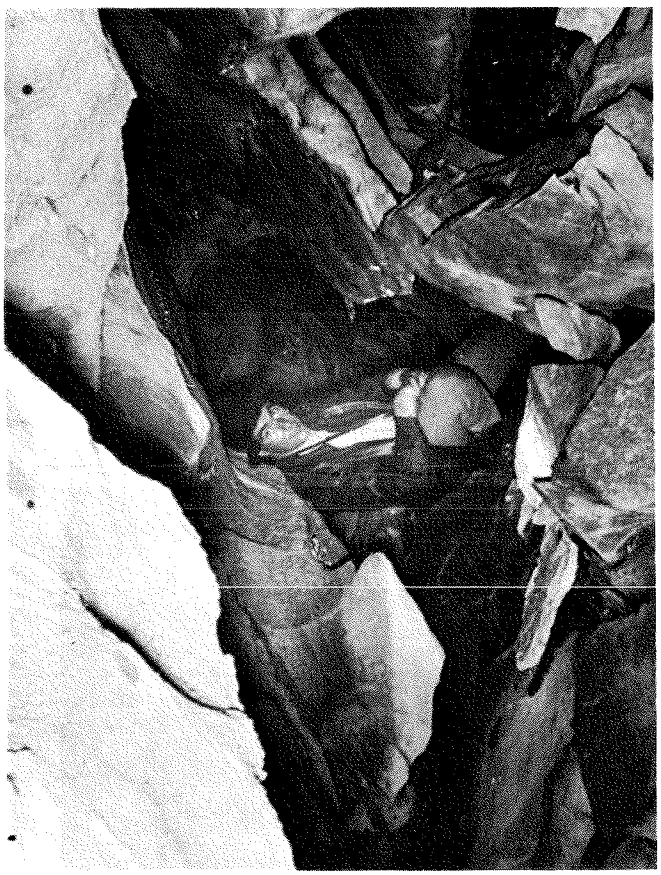

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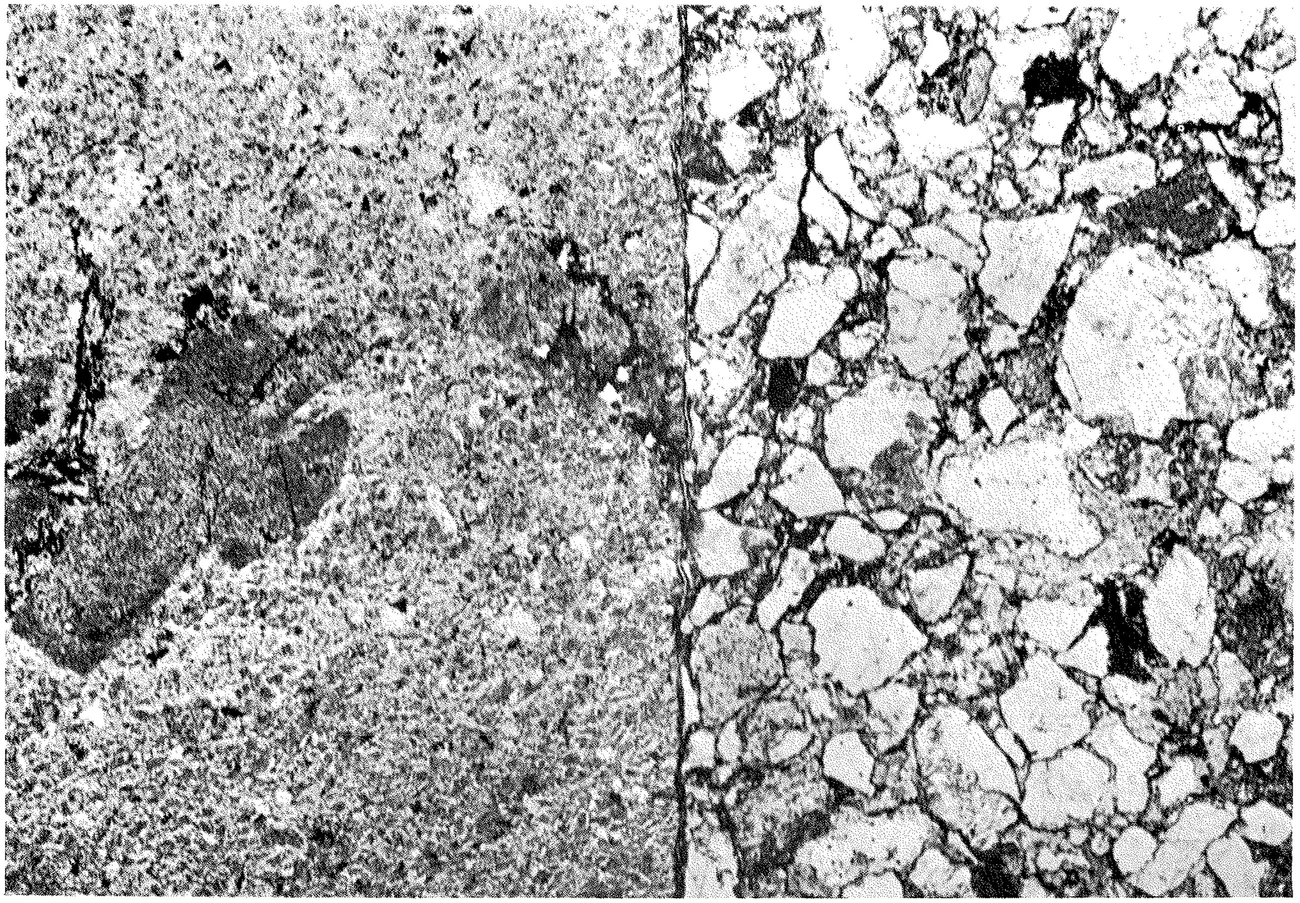

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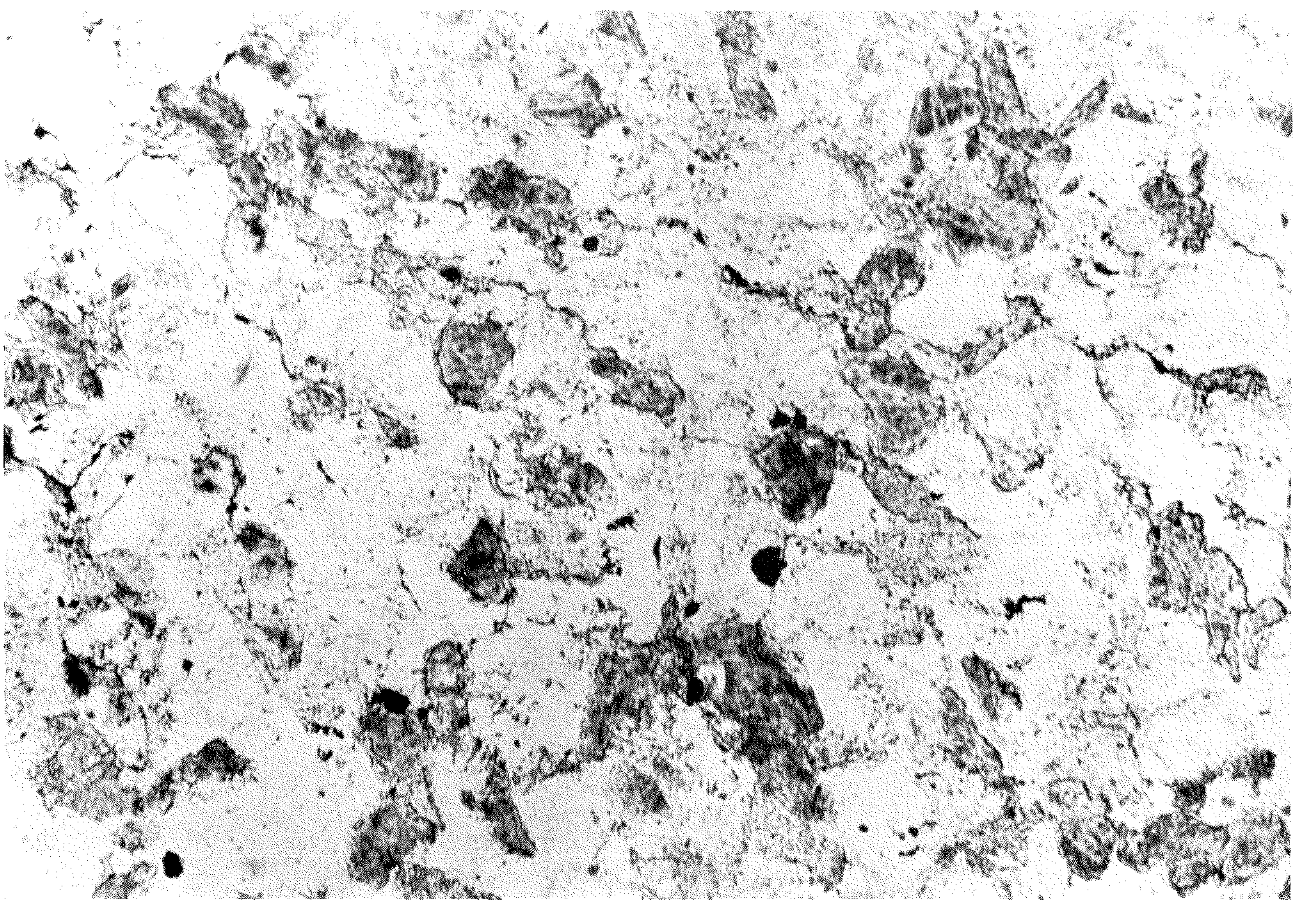

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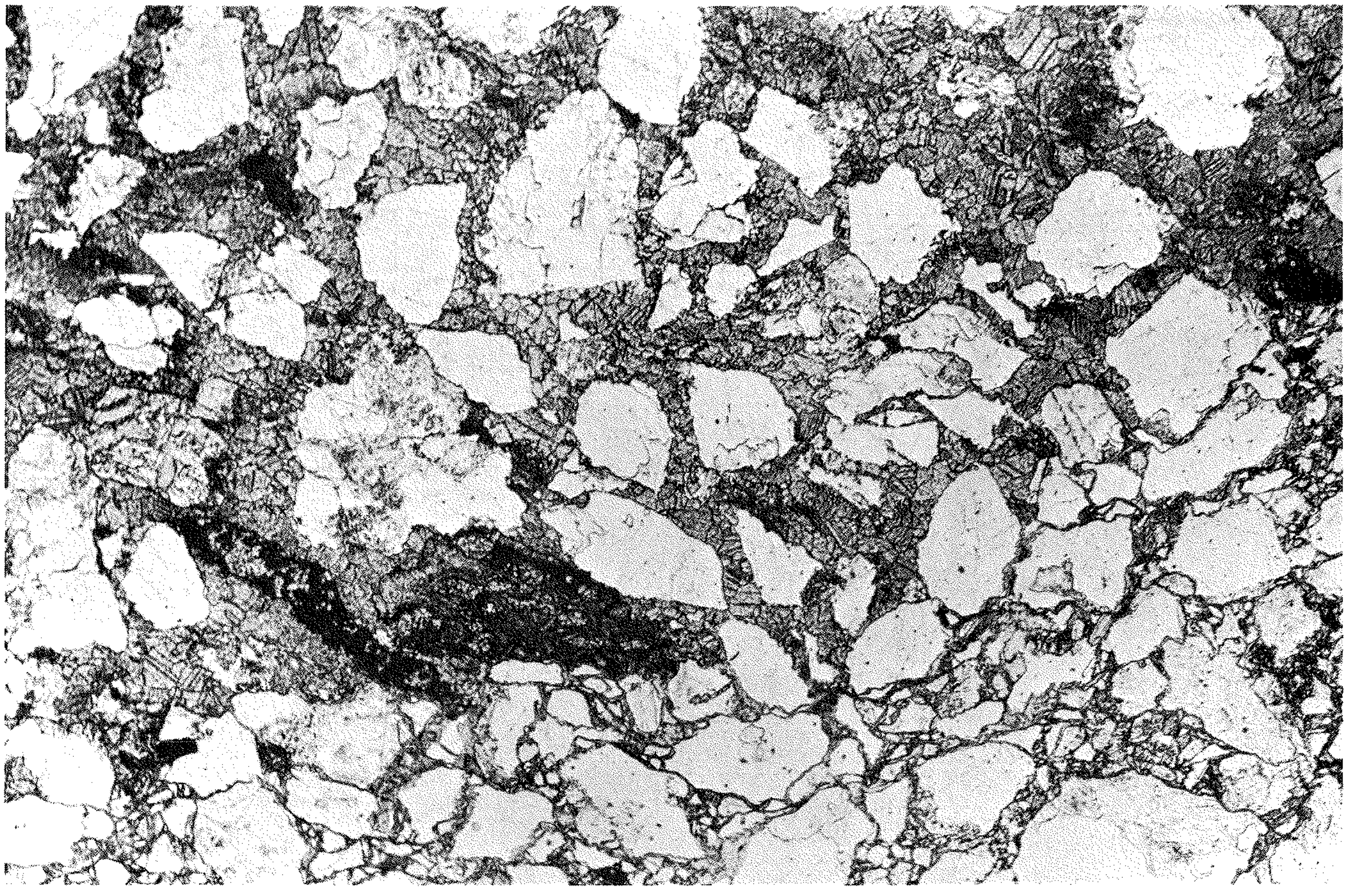

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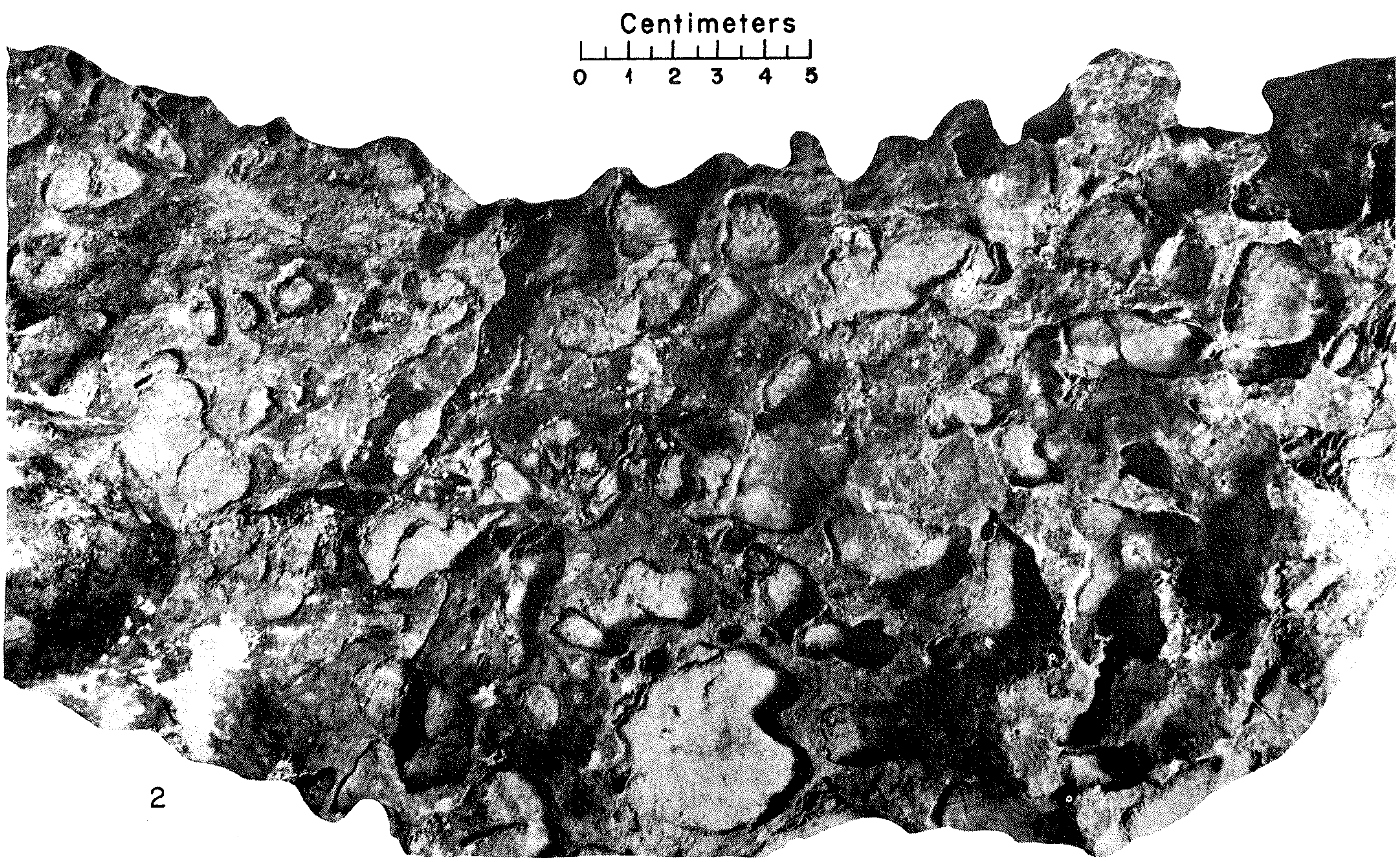

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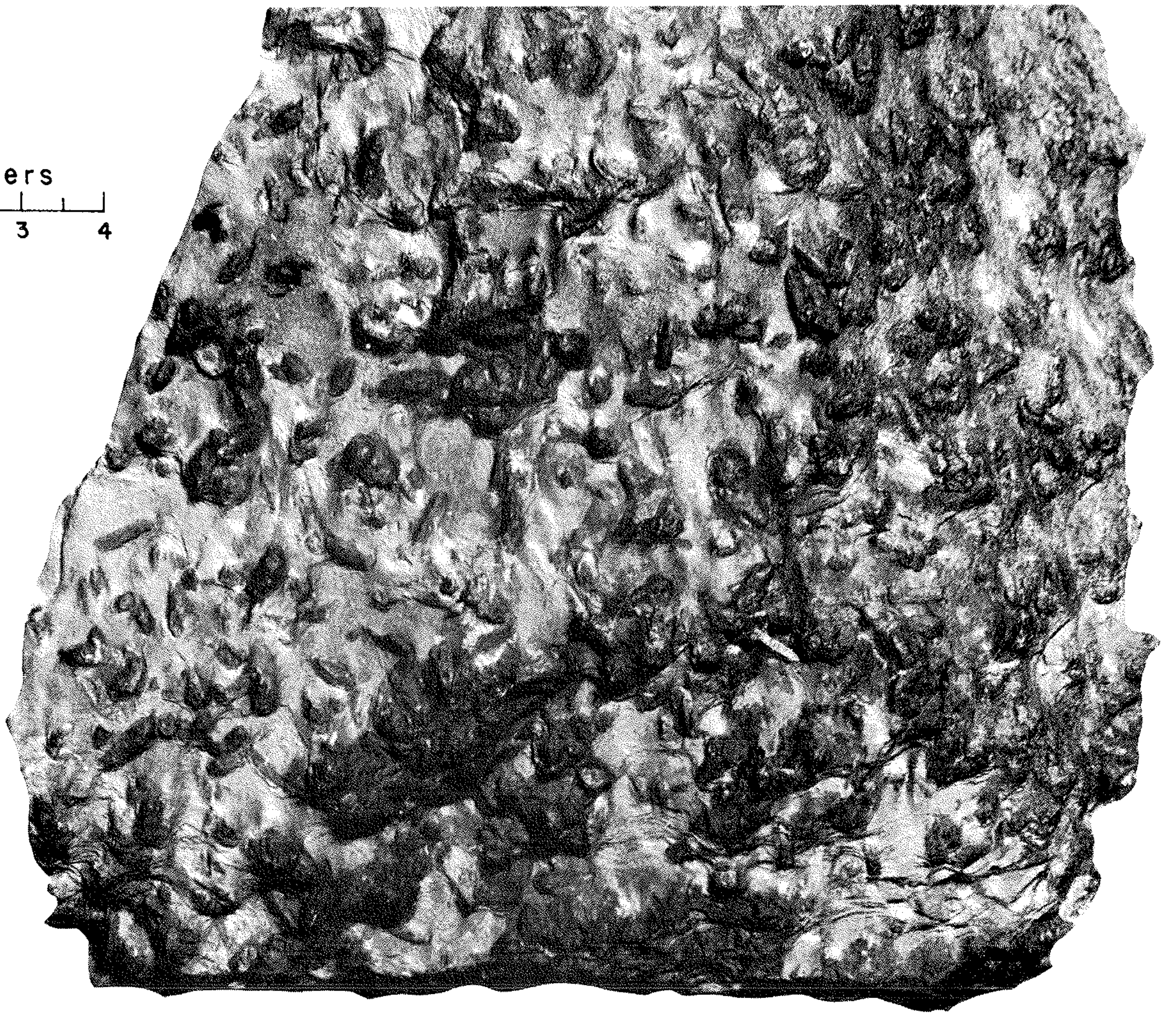

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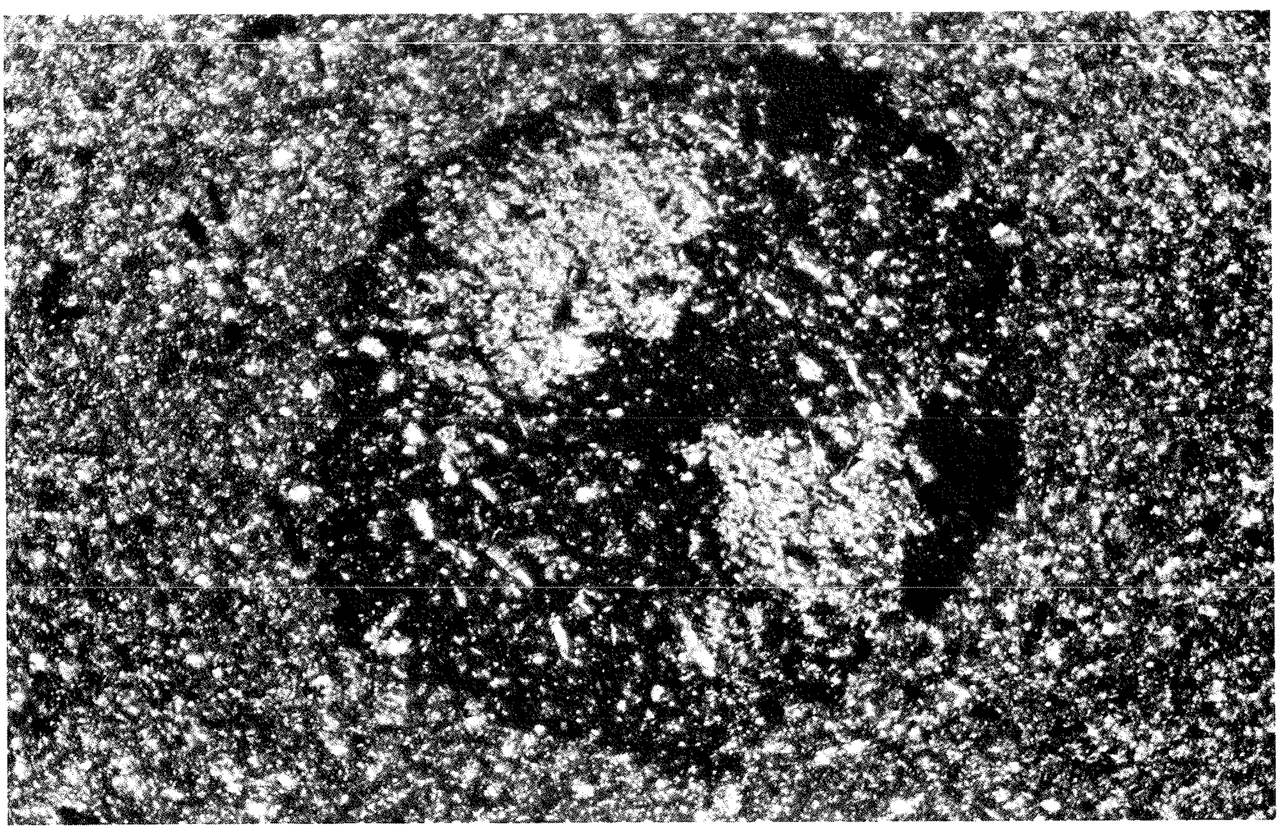

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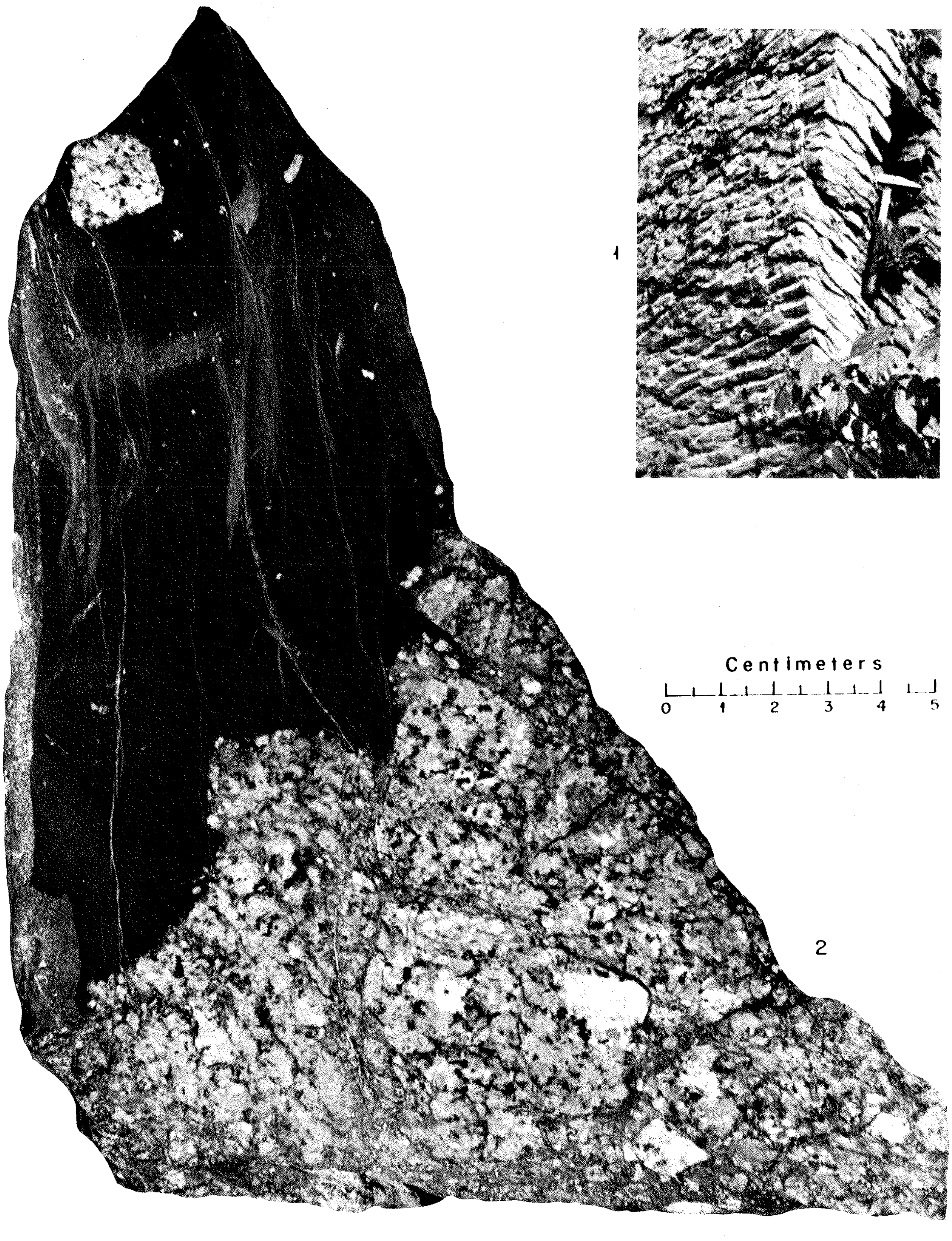

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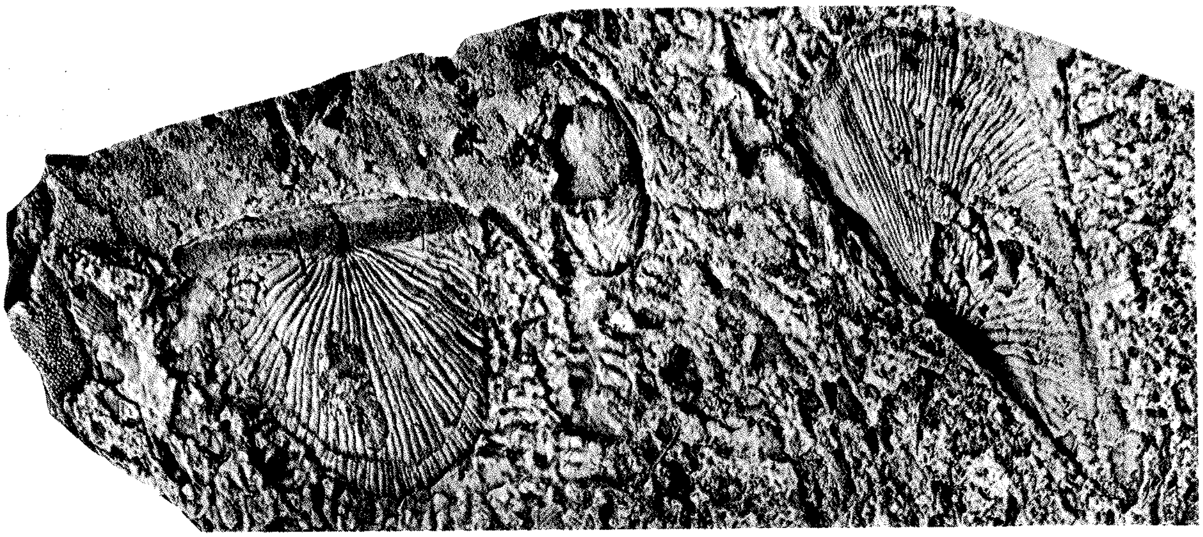

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3

APPENDIX I

FOSSIL LOCALITY REGISTER OF THE AREA CITED IN THE TEXT

(See Plate 30 for Locations)

All of the four digit numbers are from the U. S. Geological Survey's Silurian-Devonian locality file.

2690. Moose River Group, main part of Tomhegan Formation, Somerset County, Maine. Central ninth of Brassua Lake Quadrangle, along railroad southeast of Tarratine (for detailed location see Plate 15).

This locality is mentioned by Clarke (1909) as No. 3474. Asquith siding is an old name for Tarratine. Clarke's "*Rensselaeria*" is *Globithyris*. The specimens occur in a black rusty-weathering slate and are greatly distorted.

2691. Moose River Group, Tarratine Formation, Somerset County, Maine. Central ninth of Brassua Lake Quadrangle, along railroad southeast of Tarratine (for detailed location see Plate 15).

The fossils in this bed are greatly distorted, cut by cleavage, and coated with limonite where the rock is weathered.

2692. Moose River Group, Tarratine Formation, Somerset County, Maine. Edge of central and east ninths of Brassua Lake Quadrangle, along railroad southeast of Tarratine (for detailed location see Plate 15).

This locality may be one of those included in Clarke's (1909) No. 3473. Only scattered valves of *Leptocoelia* were found in the thin bedded sandstone. This occurrence is probably a death assemblage because of the difficulty with which *Leptocoelia* is ordinarily unhinged.

2693. Moose River Group, Tarratine Formation, Somerset County, Maine. Near boundary of central and east ninths of Brassua Lake Quadrangle, along railroad southeast of Tarratine (for detailed location see Plate 15).

The fossils occur in a densely packed shell bed.

2694. Moose River Group, Tarratine Formation, Somerset County, Maine. Near boundary of central and east ninths of Brassua Lake Quadrangle, along railroad southeast of Tarratine (for detailed location see Plate 15).

The fossils occur in a densely packed shell bed.

2695. Moose River Group, Tarratine Formation, Somerset County, Maine. Near boundary of central and east ninths of Brassua Lake Quadrangle, along railroad southeast of Tarratine (for detailed location see Plate 15).

The fossils occur in a densely packed shell bed.

2696. Moose River Group, Tarratine Formation, Somerset County, Maine. Edge of central and east ninths of Brassua Lake Quadrangle, along railroad southeast of Tarratine (for detailed location see Plate 15).

This locality may be one of those included in Clarke's (1909) No. 3473. The fossils occur as scattered single valves on a bedding plane. The shells are relatively small, and may be a death assemblage.

2697. Moose River Group, Tarratine Formation, Somerset County, Maine. Edge of central and east ninths of Brassua Lake Quadrangle, along railroad southeast of Tarratine (for detailed location see Plate 15).

This locality may be one of those included in Clarke's (1909) No. 3473. The fossils occur in a thin shell bed.

2698. Moose River Group, Tarratine Formation, Somerset County, Maine. Edge of central and east ninths of Brassua Lake Quadrangle, along railroad southeast of Tarratine (for detailed location see Plate 15).

This locality may be one of those included in Clarke's (1909) No. 3473.

The fossils occur as single valves scattered on a bedding plane and may constitute a death assemblage.

2699. Moose River Group, Tarratine Formation, Somerset County, Maine. Edge of central and east ninths of Brassua Lake Quadrangle, along railroad southeast of Tarratine (for detailed location see Plate 15).

This locality may be one of those included in Clarke's (1909) No. 3473.

The fossils occur in a shell bed.

2700. Moose River Group, Tarratine Formation, Somerset County, Maine. Edge of central and east ninths of Brassua Lake Quadrangle, along railroad southeast of Tarratine (for detailed location see Plate 15).

This may be one of the localities included in Clarke's (1909) No. 3473.

The fossils occur in a shell bed.

2701. Moose River Group, Tarratine Formation, Somerset County, Maine. Edge of central and east ninths of Brassua Lake Quadrangle, along railroad southeast of Tarratine (for detailed location see Plate 15).

The fossils occur in a shell bed.

2702. Moose River Group, Tarratine Formation, Somerset County, Maine. Near edge of central and east ninths of Brassua Lake Quadrangle, along railroad southeast of Tarratine (for detailed location see Plate 15).

The fossils occur in a badly deformed shell bed.

2703. Moose River Group, Tarratine Formation, Somerset County, Maine. Edge of central and east ninths of Brassua Lake Quadrangle, along railroad southeast of Tarratine (for detailed location see Plate 15).

This locality may be one of those included in Clarke's (1909) No. 3473. The fossils occur in a thin shell bed.

2704. Moose River Group, Tarratine Formation, Somerset County, Maine. Edge of central and east ninths of Brassua Lake Quadrangle, along railroad southeast of Tarratine (for detailed location see Plate 15).

This locality may be one of those included in Clarke's (1909) No. 3473. The fossils occur in a shell bed.

2705. Moose River Group, Tarratine Formation, Somerset County, Maine. Edge of central and east ninths of Brassua Lake Quadrangle, along railroad southeast of Tarratine (for detailed location see Place 15).

This locality may be one of those included in Clarke's (1909) No. 3473. The fossils occur in a shell bed.

2706. Moose River Group, Tarratine Formation, Somerset County, Maine. Edge of central and east ninths of Brassua Lake Quadrangle, along railroad southeast of Tarratine (for detailed location see Plate 15).

This locality may be one of those included in Clarke's (1909) No. 3473. The fossils occur as single valves scattered on a bedding plane and probably belong to a death assemblage.

2707. Moose River Group, Tarratine Formation, Somerset County, Maine. Edge of central and east ninths of Brassua Lake Quadrangle, along railroad southeast of Tarratine (for detailed location see Plate 15).

2708. Moose River Group, Tarratine Formation, Somerset County, Maine. Edge of central and east ninths of Brassua Lake Quadrangle, along railroad southeast of Tarratine (for detailed location see Plate 15).

This locality may be one of those included in Clarke's (1909) No. 3473. The fossils occur in a shell bed.

2709. Moose River Group, Tarratine Formation, Somerset County, Maine. Edge of central and east ninths of Brassua Lake Quadrangle, along railroad southeast of Tarratine (for detailed location see Plate 15).

2710. Moose River Group, Tarratine Formation, Somerset County, Maine. Edge of central and east ninths of Brassua Lake Quadrangle, along railroad southeast of Tarratine (for detailed location see Plate 15).

This locality may be one of those included in Clarke's (1909) No. 3473. The fossils occur in a thin shell bed.

2711. Moose River Group, Tarratine Formation, Somerset County, Maine. Edge of central and east ninths of Brassua Lake Quadrangle, along railroad southeast of Tarratine (for detailed location see Plate 15).

This locality may be one of those included in Clarke's (1909) No. 3473. The fossils occur in a shell bed.

2712. Lower Conglomerate Member of Hobbstown Formation, Somerset County, Maine. North ninth of Spencer Quadrangle, in extreme southeast corner of the ninth, on the *"9" of "2009"* foot hill.

This locality is Woodard's (1950) Locality W108-S50.

2713. Moose River Group, Tomhegan Formation, Somerset County, Maine. Central ninth of Brassua Lake Quadrangle, on Misery Stream (for detailed location see Plate 16).

This locality is Clarke's (1909) No. 3475, exclusive of bed No. 4 which is our No. 2715. Cloud and Bridge (unpublished notes 1941) called this locality No. 82. This is the type locality for both *Globithyris callida* and *Globithyris diana.* The best specimens occur in mudstone nodules, whereas those in the slate are badly distorted. The great number of small whole shells suggests that the fossils belong to a life assemblage.

2714. Moose River Group, Tomhegan Formation, Somerset County, Maine. Central ninth of Brassua Lake Quadrangle, along Misery Stream (for detailed location see Plate 16).

2715. Moose River Group, Tomhegan Formation, Somerset County, Maine. Central ninth of Brassua Lake Quadrangle, along Misery Stream (for detailed location see Plate 16).

This locality is Clarke's (1909) No. 3475-4, and is the bed from which Clarke's (1909, pl. 17) *"Rensselaeria* cf. *crassicosta"* was collected. This bed is Bridge and Cloud's (unpublished notes 1941) No. 82a, from which they obtained *"Rensselaeria" crassicosta.* Clarke (1909) reports the following from 3475: *Rensselaeria callida, R. diania, Aviculopecten flammiger, Allerisma, Chonetes nectus, Chonostrophia dawsoni,* and *Chonetes canadensis.* Inspection of Clarke's collections at Albany proves that Nylander collected a fossil-bearing boulder of the Tarratine Formation at this locality and that it is in this boulder that the following were found: *Aviculopecten flammiger, Chonostrophiella dawsoni, "Chonetes" canadensis. Meristella* and *Leptocoelia flabellites* are also present in the fragments of this boulder. *Allerisma* may have been collected in situ, but *"Chonetes" nectus* was probably collected from float.

The fossils occur as single valves scattered in a thick bed of rusty quartzite, and probably belong to a death assemblage.

2716. Moose River Group, Tarratine Formation, Somerset County, Maine. Southeast ninth of Long Pond Quadrangle, along Parlin Stream (for detailed location see Plate 20).

The fossils at this locality are probably a life assemblage as discussed by Boucot (1953) in discussion of sample six.

2717. Moose River Group, Tarratine Formation, Somerset County, Maine. Southeast ninth of Long Pond Quadrangle, along Parlin Stream (for detailed location see Plate 20).

This locality may be one of those in Williams' (1900) section 1059C, and is close to Bridge and Cloud's (unpublished notes 1941) locality 84, probably part of their bed P. The fossils at this locality are scattered on bedding planes and probably belong to a death assemblage.

2718. Moose River Group, Tarratine Formation, Somerset County, Maine. Southeast ninth of Long Pond Quadrangle, along Parlin Stream (for detailed location see Plate 20).

This locality is a part of Williams' (1900) section 1059C, and corresponds to Bridge and Cloud's (unpublished notes 1941) locality 84. The fossils occur in a shell bed, discussed by Boucot (1953) as bed five. This is the type locality for *Mutationella parlinensis.*

2719. Moose River Group, Tarratine Formation, Somerset County, Maine. Southeast ninth of Long Pond Quadrangle, along Parlin Stream (for detailed location see Plate 20).

This locality is included in Williams' (1900) section 1059C, although it probably had not been collected previous to 1948. The fossils occur in a three inch thick shell bed covered by about ten feet of subgraywacke which must be removed before collecting is possible. This locality corresponds to Boucot's (1953) bed four.

2720. Moose River Group, Tarratine Formation, Somerset County, Maine. Southeast ninth of Long Pond Quadrangle, along Parlin Stream (for detailed location see Plate 20).

This locality is included in Williams' (1900) section 1059C, and is also included in Bridge and Cloud's (1900) locality 83. Pirsson and Schuchert (1914) may have described material which was derived from loose blocks fallen from this locality. This locality corresponds to Boucot's (1953) bed three. The fossils occur in a shell bed.

2721. Moose River Group, Tarratine Formation, Somerset County, Maine. Southeast ninth of Long Pond Quadrangle, along Parlin Stream (for detailed location see Plate 20).

This locality is part of Williams' (1900) section 1059C. This locality was probably not collected prior to 1948. The fossils occur in a shell bed. This locality corresponds to Boucot's (1953) bed two.

2722. Moose River Group, Tarratine Formation, Somerset County, Maine. Southeast ninth of Long Pond Quadrangle, along Parlin Stream (for detailed location see Plate 20).

Pirsson and Schuchert (1914) described material derived from loose blocks in the vicinity of this locality. This locality is part of Williams' (1900) section 1059C; most of Williams' specimens probably being collected from loose blocks. Williams and Breger (1916) confuse the material collected from loose blocks with those in outcrop in such a manner that it is impossible to be sure of the derivation. The *Rensselaeria callida* cited

by Schuchert (1914) from this locality belongs to *Mutationella parlinensis*. The fossils at this locality are scattered through beds of subgraywacke. This locality corresponds to Boucot's (1953) bed one.

2723. Moose River Group, Tomhegan Formation, Piscataquis County, Maine. Northeast ninth of Brassua Lake Quadrangle, on southeast shore of Farm Island, at an elevation of 1030 feet, due east of the *"d"* in *"Island"* (Plate 18).

The fossils occur as scattered shells on a bedding plane.

2724. Moose River Group, Tomhegan Formation, Piscataquis County, Maine. Northeast ninth of Brassua Lake Quadrangle, on southeast shore of Farm Island on the first point northeast of the point on which are three buildings and a boat landing (Plate 18).

2725. Moose River Group, Seboomook Formation, Somerset County, Maine. Central ninth of the Long Pond Quadrangle, in a pasture on northside of Jackman-Rockwood road (State Route 15), on east side of Jackman - Long Pond township boundary. Outcrop extends from near the road halfway to RR tracks and is the most easterly of the large outcrops in the pasture (Plate 28).

2726. Moose River Group, Tarratine Formation, Somerset County, Maine. Central ninth of Long Pond Quadrangle, on northside of Jackman-Rockwood road (State Route 15), 1.45 miles by speedometer east of Jackman - Long Pond township boundary.

2727. Moose River Group, Tarratine Formation, Somerset County, Maine. East ninth of Long Pond Quadrangle, about 200 ft. east of Jackman-Rockwood road (State Route 15), about 3.9 miles by speedometer east of Jackman - Long Pond township boundary.

The fossils occur in a shell bed.

2728. Hardwood Mountain Formation, Somerset County, Maine. North ninth of Spencer Quadrangle, in southeast corner 0.6 mile N97E of the top of 2160-foothill.

This locality is the same as Woodard's (1950) W200-S50.

2729. Moose River Group, Tarratine Formation, Somerset County, Maine. East ninth of Spencer Quadrangle, on south shore of Spencer Lake, 2675 feet northeast from the top of 1540-foot hill.

This locality is the same as Woodard's (1950) M300-S50. The fossils occur in a shell bed.

2730. Moose River Group, Tomhegan Formation, Somerset County, Maine. North ninth of Brassua Lake Quadrangle, 0.4 mile N53W from southeast corner of Brassua township on point about 0.85 mile north northwest from pre-dam inlet of Moose River.

This is Bridge and Cloud's (unpublished notes 1941) locality No. 85. The fossils were collected from a loose block on the south side of the point. Bridge and Cloud thought this locality was near Williams' (1900) locality 1062A.

2731. Moose River Group, Tarratine Formation, Somerset County, Maine. Central ninth of Long Pond Quadrangle, in railroad cut about 0.4 mile from point where the railroad crosses the Jackman - Long Pond boundary to the west, and directly north of the Route 15 symbol.

The fossils occur in a shell bed.

2732. Moose River Group, Tarratine Formation, Somerset County, Maine. Central ninth of Long Pond Quadrangle, on south side of railroad, 1 mile west of Long Pond railroad station (located near BM 1192) S10W of the *"n"* in *"long."*

2733. Moose River Group, Tarratine Formation, Somerset County, Maine. Central ninth of Long Pond Quadrangle, on south side of railroad track about 100 feet east of Loc. 2732.

2734. Moose River Group, Tarratine Formation, Somerset County, Maine. Central ninth of Long Pond Quadrangle, in railroad embankment, north of the *"n"* in *"long."*

The fossils occur as scattered shells on bedding planes.

2735. Moose River Group, Tarratine Formation, Somerset County, Maine. East ninth of Long Pond Quadrangle, in first railroad cut to the west of the delta of Parlin Stream, above *"C"* in *"Canadian."*

The fossils occur in a thin shell bed.

2736. Moose River Group, Tomhegan Formation, Somerset County, Maine. Central ninth of Brassua Lake Quadrangle, in railroad cut south of Little Brassua Lake, due east of the base of the second *"I"* in *"PACIFIC."*

2737. Seboomook Formation, Somerset County, Maine. East ninth of Spencer Quadrangle, on southwest shore of Spencer Lake, 2120 feet south of the *"E"* in *"LAKE."*

This is locality W12-S50 of Woodard (1950).

2738. Moose River Group, Tarratine Formation, Somerset County, Maine. West ninth of Moosehead Lake Quadrangle, near Rockwood (for detailed location see Plate 23).

2739. Moose River Group, Tarratine Formation, Somerset County, Maine. West ninth of Moosehead Lake Quadrangle, near Rockwood (for detailed location see Plate 23).

The fossils occur as scattered shells on bedding planes.

2740. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Moosehead Lake Quadrangle, near Rockwood (for detailed location see Plate 23).

The fossils occur as scattered shells on bedding planes.

2741. Moose River Group, Tarratine Formation, Somerset County, Maine. East ninth of Spencer Quadrangle, near south end of Spencer Lake, 360 feet north of the *"5"* in *"1593"* foot hill.

This is locality W47-S50 of Woodard (1950).

2742. Kennebec Formation, Somerset County, Maine. East ninth of Brassua Lake Quadrangle, just south of north boundary of Misery Gore and about 0.34 mile northeast from railroad overpass at Somerset Junction, on northwest side of abandoned railroad now surfaced for automobiles.

The fossils occur as scattered shells in beds of fine-grained tuff.

2743. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Moosehead Lake Quadrangle, near Rockwood (for detailed location see Plate 23).

The fossils occur in a thin shell bed.

2744. Moose River Group, Tarratine Formation, Somerset County, Maine. Southeast ninth of Seboomook Lake Quadrangle, on south side of Soccatean Point, Moosehead Lake, on the shore north of the *"Q"* in *"PISCATAQUIS."*

The fossils occur in a shell bed.

2745. Moose River Group, Tarratine Formation, Somerset County, Maine. East ninth of Spencer Quadrangle, near south end of Spencer Lake 3400 feet due north of the *"8"* in *"B.M. 1098."* Outcrops in stream bed.

This is Woodard's (1950) locality W53-S50.

2746. Moose River Group, Tarratine Formation, Somerset County, Maine. Northeast ninth of Brassua Lake Quadrangle, in ledges at the tip of Tomhegan Point that extend out into the lake on the west side of the point.

The fossils occur as scattered shells on bedding planes.

2747. Moose River Group, Tarratine Formation, Somerset County, Maine. Northeast ninth of Pierce Pond Quadrangle, on west bank of Cold Stream about 200 feet below the most northerly dam in this ninth of the Quadrangle.

2748. Seboomook Formation, Somerset County, Maine. Northeast ninth of Brassua Lake Quadrangle, on north side of Tomhegan Cove, on the shore due west of the *"C"* in *"Camp."*

2749. Moose River Group, Tarratine Formation, Somerset County, Maine. East ninth of Spencer Quadrangle, on extreme eastern boundary, 800 feet due south from intersection of the eastern quadrangle boundary and the township line which separates T3, R5 from Hobbstown township.

This includes Woodard's (1950) localities W69-S50, W70-S50, and W70a-S50 which are all stated to represent the same locality.

2750. Moose River Group, Tomhegan Formation, Somerset County, Maine. Northeast ninth of Brassua Lake Quadrangle, on end of Baker Brook Point. The actual outcrops are ledges located about 100 feet in from the point. From them blocks have been moved to the shore, where much of the collection was made.

This is Clarke's (1909) localities 2454 and 3455. The fossils occur as scattered shells in dark sandstone. Many of the loose blocks have been moved from the ledges by ice push. Some of the material is closely enough packed to constitute a shell bed.

2751. Moose River Group, Tarratine Formation, Somerset County, Maine. East ninth of Spencer Quadrangle, near south end of Spencer Lake, 1060 feet due north from the top of 1593-foot hill.

This is Woodard's (1950) localities W71-S50 and W72-S50.

2752. Moose River Group, Tomhegan Formation, Somerset County, Maine. Northeast ninth of Brassua Lake Quadrangle, on north side of Baker Brook Cove, on the west side of a small point about 0.2 mile north of the *"a"* in *"Baker Brook Cove."*

The fossils occur in a thin shell bed. A single scrap of bone was found associated with the invertebrates.

2753. Moose River Group, Tarratine Formation, Somerset County, Maine. North central ninth of Brassua Lake quadrangle, same location as 163; a boulder Loc. 86A was taken from a block about 12′ x 5′ x 7′ which lay about 300′ W. of loc. 86 (163) and was probably not far out of place. This collection of Bridge and Cloud's (1941, p. 102, unpublished notes) is from a block derived from the Tarratine Formation. The nearest Tarratine Formation in situ is located to the northwest. The other loose blocks at this locality all belong to the Tomhegan Formation. The Tarratine age is shown by both the lithology and the presence of *Leptocoelia flabellites.*

2754. Moose River Group, Tomhegan Formation, Somerset County, Maine. Northeast ninth of Brassua Lake Quadrangle, on shore of Moosehead Lake (for detailed location see Plate 17).

2755. Moose River Group, Tomhegan Formation, Somerset County, Maine. Northeast ninth of Brassua Lake Quadrangle, on shore of Moosehead Lake (for detailed location see Plate 17).

The fossils occur as scattered single valves.

2756. Moose River Group, Tomhegan Formation, Somerset County, Maine. Northeast ninth of Brassua Lake Quadrangle, on shore of Moosehead Lake (for detailed location see Plate 17).

2757. Moose River Group, Tomhegan Formation, Somerset County, Maine. Northeast ninth of Brassua Lake Quadrangle, on shore of Moosehead Lake (for detailed location see Plate 17).

This is the only locality in the synclinorium where abundant pelecypod steinkerns occur and probably represents a life assemblage.

2758. Moose River Group, Tomhegan Formation, Somerset County, Maine. Northeast ninth of Brassua Lake Quadrangle, on shore of Moosehead Lake (for detailed location see Plate 17).

The fossils occur as scattered single valves.

2759. Moose River Group, Tomhegan Formation, Somerset County, Maine. North ninth of Brassua Lake Quadrangle, on east shore of Brassua Lake one mile N45E from pre-dam inlet of Moose River.

The fossils occur in thin shell beds.

2760. Seboomook Formation, Somerset County, Maine. North ninth of Brassua Lake Quadrangle, about 0.3 mile N30W of the *"O"* in *"TOMHEGAN"* in outcrops which normally are covered by the waters of Brassua Lake but which protrude as small rocks at low water.

This locality is included in Williams' (1900) section 1062B; raising of the lake level since that time has covered the natural landmarks which might locate this locality more exactly within Williams' section. The fossils occur as scattered shells.

2761. Seboomook Formation, Somerset County, Maine. North ninth of Brassua Lake Quadrangle, on present west bank of Brassua Stream 0.7 mile N60W from the *"S"* in *"Stream."*

This locality may be one of those in Williams' (1900) section 1062B. The fossils occur as scattered shells.

2762. Moose River Group, Tomhegan Formation, Somerset County, Maine. Central ninth of Brassua Lake Quadrangle, on present shore of Brassua Lake S32W from the *"E"* in *"LAKE"* at an elevation of 1080 ft.

2763. Moose River Group, Tomhegan Formation, Somerset County, Maine. Central ninth of Brassua Lake Quadrangle, on present shore of Brassua Lake S54W from the *"K"* in *"LAKE"* at an elevation of 1060 ft.

2764. Moose River Group, Tomhegan Formation, Somerset County, Maine. Central ninth of Brassua Lake Quadrangle, 0.4 mile south of the westernmost edge of the second *"R"* in *"MOOSE RIVER,"* on the shores of the swamp which has now been flooded by the damming of Brassua Lake.

The fossils occur in shell beds as groups of well sorted steinkerns.

2765. Moose River Group, Tarratine Formation, Somerset County, Maine. East ninth of Long Pond Quadrangle about 150 feet from northeast shore of Fogg Pond, S48W from top of 1400-foot hill.

The fossils occur in a shell bed.

2766. Moose River Group, Tarratine Formation, Somerset County, Maine. Central ninth of Long Pond Quadrangle, 5300 feet N51E of the top of 2040-foot hill, at an elevation of 1280 feet.

The fossils occur in a thin shell bed.

2767. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Moosehead Lake Quadrangle, near Rockwood (for detailed location see Plate 23).

The fossils occur in a shell bed and are coated with drusy albite. Many of the specimens show evidence of abrasion and breakage of the anterior margins.

2768. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Moosehead Lake Quadrangle, near Rockwood (for detailed location see Plate 23).

The fossils occur in a thin shell bed.

2769. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Moosehead Lake Quadrangle, near Rockwood (for detailed location see Plate 23).

The fossils occur in a thin shell bed.

2770. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Moosehead Lake Quadrangle, near Rockwood (for detailed location see Plate 23).

The fossils occur in a shell bed.

2771. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Moosehead Lake Quadrangle, near Rockwood (for detailed location see Plate 23.)

The fossils occur in a shell bed.

2772. Moose River Group, Tomhegan Formation, Somerset County, Maine. Southwest ninth of Brassua Lake Quadrangle, in outcrops surrounding southeast outlet of unnamed pond 0.4 mile northwest of Misery Pond.

The brachiopods occur as steinkerns; the pelecypods as single valves, scattered through dark sandstone.

2773. Hardwood Mountain Formation, Somerset County, Maine. Northeast ninth of Spencer Quadrangle, in extreme southwest corner of ninth, 3160 feet due south from "*0*" in "*2012*" foot hill.

This is Woodard's (1950) locality W92-S50.

2774. Seboomook Formation, Somerset County, Maine. Central ninth of Long Pond Quadrangle, on southeast side of the small island in Long Pond that is south of the Upper Narrows.

2775. Moose River Group, Tarratine Formation, Somerset County, Maine. Central ninth of Long Pond Quadrangle, on north shore of Long Pond due north of the "*we*" in "*Lower Narrows.*"

The fossils occur as scattered shells on bedding planes.

2776. Moose River Group, Tarratine Formation, Somerset County, Maine. Central ninth of Long Pond Quadrangle, on south shore of Long Pond, S33E of the "*N*" in "*LONG.*"

The fossils occur as scattered shells on bedding planes.

2777. Moose River Group, Tarratine Formation, Somerset County, Maine. Central ninth of Long Pond Quadrangle, on south shore of Long Pond on point S17E of the "*G*" in "*LONG POND.*"

This locality may be Williams' (1900) locality 1060B4.

The fossils occur in shell beds.

2778. Moose River Group, Tarratine Formation, Somerset County, Maine. Central ninth of Long Pond Quadrangle, in near-shore outcrop about 200 feet east of Loc. 2777.

2779. Moose River Group, Tarratine Formation, Somerset County, Maine. East ninth of Long Pond Quadrangle, on south shore of Long Pond, 3100 feet N19E of top of 1280-foot hill.

The fossils occur as scattered shells on bedding planes.

2780. Moose River Group, Tarratine Formation, Somerset County, Maine. East ninth of Long Pond Quadrangle, on islands about 1 mile west of the outlet of Long Pond.

2781. Moose River Group, Tarratine Formation, Somerset County, Maine. East ninth of Long Pond Quadrangle, about 300 feet from the north shore of Long Pond on unmapped islet under the "*a*" in "*Churchill Camp.*"

The fossils occur as scattered shells on bedding planes.

2782. Moose River Group, Tarratine Formation, Somerset County, Maine. East ninth of Long Pond Quadrangle, on north shore of Long Pond about 0.2 mile east of easternmost point on north side of Lower Narrows.

2783. Moose River Group, Tarratine Formation, Somerset County, Maine. Central ninth of Long Pond Quadrangle, on north shore of Long Pond N2W from BM 1192.

The fossils occur in a shell bed.

2784. Moose River Group, Tarratine Formation, Somerset County, Maine. Central ninth of Long Pond Quadrangle, on north shore of Long Pond N45W from BM 1192.

2785. Moose River Group, Tarratine Formation, Somerset County, Maine. Central ninth of Long Pond Quadrangle, on north shore of Long Pond 100 feet west of Loc. 2784.

The fossils occur as scattered shells.

2786. Moose River Group, Tarratine Formation, Somerset County, Maine. Central ninth of Long Pond Quadrangle, on north shore of Long Pond 400 feet west of Loc. 2784.

The fossils occur in a shell bed.

2787. Moose River Group, Tarratine Formation, Somerset County, Maine. Central ninth of Long Pond Quadrangle, on north shore of Long Pond on northwest side of point southwest of the "*O*" in "*LONG.*"

2788. Seboomook Formation, Somerset County, Maine. Central ninth of Long Pond Quadrangle, on north shore of Long Pond 3700 feet N91E of top of 1240-foot hill.

The fossils occur as scattered shells on bedding planes.

2789. Moose River Group, Tarratine Formation, Somerset County, Maine. North ninth of Pierce Pond Quadrangle, 1 mile northeast of Mountain Pond, on the crest of Coburn Mountain at an elevation of 2680 feet, in dense woods.

2790. Moose River Group, Tarratine Formation, Somerset County, Maine. North ninth of Pierce Pond Quadrangle, on southwest side of knob 2500 feet N84E of

top of 2820-foot hill, at an elevation of 3100 feet, in dense woods.

The fossils occur in a thin shell bed.

2791. Moose River Group, Tomhegan Formation, Somerset County, Maine. Central ninth of Brassua Lake Quadrangle, on south side of Misery Stream about ⅛ mile upstream from Depot Camp.

The fossils occur as steinkerns.

2792. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Pierce Pond Quadrangle, at an elevation of 1800 feet on east side of Enchanted Pond, 4000 feet S51E from BM 1461.

2793. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Pierce Pond Quadrangle, about 200 feet south of Enchanted Pond - Little Enchanted Pond trail, S9W from the outlet of McKenney Ponds.

The fossils occur as scattered shells on bedding planes.

2794. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Pierce Pond Quadrangle, in stream bed 0.05 mile north of the point where the trail from Little Enchanted Pond crosses the outlet stream from McKenney Ponds.

2795. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Pierce Pond Quadrangle, 0.1 miles upstream from Loc. 2794.

The fossils occur as scattered shells on bedding planes.

2796. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Pierce Pond Quadrangle, in a rocky gorge, on south bank of Enchanted Stream, N7E from top of 1960-foot hill.

The fossils occur in a shell bed.

2797. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Pierce Pond Quadrangle, on Enchanted Stream 300 yards upstream from Loc. 2796.

The fossils occur as scattered shells.

2798. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Pierce Pond Quadrangle, on Enchanted Stream 0.8 mile downstream from the outlet of Little Enchanted Pond.

The fossils occur as scattered shells.

2799. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Pierce Pond Quadrangle, on Enchanted Stream 0.25 mile downstream from the outlet of Enchanted Pond, in the bed of the stream.

The fossils occur in a shell bed.

2800. Moose River Group, Tarratine Formation, Somerset County, Maine. West ninth of Pierce Pond Quadrangle, on Enchanted Stream 500 feet downstream from the the point where the 1340 foot contour crosses the stream, at the north end of a swamp.

2801. Seboomook Formation, Somerset County, Maine. Central ninth of Pierce Pond Quadrangle, in first outcrop in the bed of Enchanted Stream south of Granny's Cap, west of the *"E"* in *"Enchanted."*

2802. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Pierce Pond Quadrangle, on south bank of stream that drains into northeast side of Enchanted Pond east of the *"a"* in *"Enchanted,"* at an elevation of about 2150 feet.

The fossils occur as scattered shells on a bedding plane.

2803. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Pierce Pond Quadrangle, on same stream as Loc. 2802, in the bed of the stream at an elevation of about 2250 feet. The fossils occur in a shell bed.

2804. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Pierce Pond Quadrangle, on southwest end of Coburn Mountain, on the middle knob of three knobs which each have an elevation of 2540 feet.

The fossils occur as scattered shells on bedding planes.

2805. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Pierce Pond Quadrangle, on southwest end of Coburn Mountain, on the southernmost knob of three knobs which have an elevation of 2540 feet.

The fossils occur as scattered shells on bedding planes.

2806. Moose River Group, Tarratine Formation, McKenney Ponds Limestone Member, Somerset County, Maine. Northwest ninth of Pierce Pond Quadrangle, in old sluiceway shown on map as western outlet of McKenney Ponds, at the foot of the ridge formed by the basement complex. Clastic limestone lies against the ridge from the Ponds southwest for about ¼ mile, following the course of the underground stream and caves. In scattered outcrops and loose slabs of limestone that could only have come from this horizon.

The fossils occur scattered through layers of limestone, and in a layer of black slate.

2807. Moose River Group, Tarratine Formation, Somerset County, Maine. West ninth of Pierce Pond Quadrangle, about 0.9 mile north of Gordon Pond, on steep northwest side of knob whose elevation is 2220 feet, just south of boundary with northwest ninth.

The fossils occur in a thin shell bed.

2808. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Pierce Pond Quadrangle, on east face of knob on Shutdown Mountain having elevation of 2522 feet.

The fossils occur in a shell bed.

2809. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Pierce Pond Quadrangle, on Shutdown Mountain, about 300 feet south of the *"O"* in *"SHUTDOWN,"* on northwest side of small valley in which are headwaters of small stream flowing to the east into Enchanted Stream.

The fossils occur as scattered shells on bedding planes.

2810. Moose River Group, Tarratine Formation, McKenney Ponds Limestone Member, Somerset County, Maine. Northwest ninth of Pierce Pond Quadrangle, in the gully at the northeast end of the most northeasterly of the McKenney Ponds, on the south side of the gully, about 100 feet away from the pond.

The fossils occur scattered through layers of limestone.

2811. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Pierce Pond Quadrangle, in cliffs on southwest side of Enchanted Pond, 5000 feet N33E from top of 2522 foot hill and about 400 feet northwest of the "crevasse" on Shutdown Mountain, at an elevation of 1970 feet.

2812. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Pierce Pond Quadrangle, on the tributary stream which enters Enchanted

Stream about 0.25 mile west of Enchanted Pond, at an elevation of 1550 feet.

The fossils occur in shell beds.

2813. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Pierce Pond Quadrangle, on the stream which flows through the camp at the north end of Enchanted Pond, about 0.15 mile upstream from the pond in the first outcrop on the northwest bank of the stream.

The fossils occur in a shell bed.

2814. Moose River Group, Tomhegan Formation, Somerset County, Maine. Same as Loc. 2730; a separate boulder.

2815. Silurian undifferentiated, Piscataquis County, Maine. Southwest ninth of Moosehead Lake Quadrangle, on shore of Moosehead Lake N22E from top of the 1260-foot hill that is immediately to the northwest of BM 1037.

This is Hitchcock's (1861, 1862) "Helderberg limestone" mentioned as occurring at the foot of Squaw Mountain and containing "*Favosites gothlandicus*." Hitchcock obtained his specimens from the lakeshore whereas we got ours in the adjacent railroad cut.

2816. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Moosehead Lake Quadrangle, near town of Rockwood (for detailed location see Plate 23).

2817. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Moosehead Lake Quadrangle, near town of Rockwood (for detailed location see Plate 23).

2818. Moose River Group, Tomhegan Formation, Piscataquis County, Maine. Northeast ninth of Brassua Lake Quadrangle, on southeast shore of Farm Island. Same as Loc. 2724 (Plate 18).

2819. Moose River Group, Tomhegan Formation, Kineo Volcanic Member, Somerset County, Maine. West ninth of Brassua Lake Quadrangle, on east bank of stream flowing south through the "*M*" of "*MISERY*," at an elevation of 1440 feet.

The fossils may have been collected from a pebble whose margins were difficult to ascertain from those of the enclosing rock matrix in the outcrop.

2820. Moose River Group, Tomhegan Formation, Somerset County, Maine. Northeast ninth of Brassua Lake Quadrangle, on Blaine-Tenmile Swing road, about 3.5 miles northwest of the bridge over Moose River. The locality is in the ditch on the east side of the road and is usually covered by earth except when heavy rains have deepened the ditch. The bed was observed and collected only in 1948.

The fossils occur in a shell bed.

2821. Moose River Group, Tarratine Formation, Somerset County, Maine. South ninth of Long Pond Quadrangle, 0.35 mile south of the island in Horseshoe Pond, on top of a bluff which overlooks the swamp west of the dam on Parlin Stream.

The fossils occur as scattered shells.

2822. Hardwood Mountain Formation, Somerset County, Maine. Central ninth of Attean Quadrangle, on north shore of Little Big Wood Pond about 0.25 mile southeast of Fox's Camp. This locality is exposed only at low water, at which time the contact with the basement complex is exposed.

2823. Moose River Group, Tarratine Formation, Somerset County, Maine. South ninth of Long Pond Quadrangle, in scattered outcrops on east side of U. S. 201, about 100 feet north of the bridge over Bean Brook.

The fossils occur as scattered shells on bedding planes. This locality is Williams' (1900) 1059D. Williams (*idem*) lists *Lissopleura aequivalvis* which is actually *Mutationella parlinensis*.

2824. Moose River Group, Tarratine Formation, Somerset County, Maine. Southeast ninth of Long Pond Quadrangle, about 0.4 mile N30E from north end of Long Pond, on southeast slope of a cliff which is visible from Long Pond, at an elevation of about 1860 feet.

The fossils occur as scattered shells on bedding planes.

2825. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Pierce Pond Quadrangle, on southwest side of the outlet of Enchanted Pond.

2826. Moose River Group, Tomhegan Formation, Somerset County, Maine. East ninth of Long Pond Quadrangle, S9W of the top of the 1620 foot hill, at an elevation of 1600 feet.

2827. Moose River Group, Tarratine Formation, Somerset County, Maine. Southeast ninth of Long Pond Quadrangle, 0.37 mile south of the top of 2430 foot hill (Parlin Mountain), at an elevation of 2170 feet.

The fossils occur in a shell bed.

2828. Moose River Group, Tarratine Formation, Somerset County, Maine. Southeast ninth of Long Pond Quadrangle, 0.17 mile S20W from the 2380 foot knob at the southwest end of Williams Mountain, at an elevation of 2140 feet.

The fossils occur as scattered valves in layers of white sandstone.

2829. Moose River Group, Tarratine Formation, Somerset County, Maine. Southeast ninth of Long Pond Quadrangle, 0.4 mile north of the inlet of the small unnamed pond immediately north of Long Pond, in a gully bed which joins the stream feeding this pond, at an elevation of 1750 feet.

2830. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Moosehead Lake Quadrangle, near the town of Rockwood (for detailed location see Plate 23).

The fossils occur as scattered shells on bedding planes.

2831. Moose River Group, Tarratine Formation, Somerset County, Maine. Southeast ninth of Long Pond Quadrangle, on southwest end of Williams Mountain, on southeast side of small knob (elevation 1840 feet) that overlooks Long Pond and Long Stream.

The fossils occur as scattered shells on bedding planes.

2832. Moose River Group, Tarratine Formation, Somerset County, Maine. Southwest ninth of Brassua Lake Quadrangle, 0.3 mile N50E of top of 2061 foot hill, at an elevation of 2010 feet on the southwest side of 2020 foot knob.

The fossils occur in a shell bed. This is the type locality of *Nanothyris hodgei*.

2833. Moose River Group, Tarratine Formation, Somerset County, Maine. West ninth of Brassua Lake Quadrangle, 0.45 mile due east of 1760 foot hill, on southwest bank of stream which here parallels Rt. 15 (Jackman-Rockwood Road; shown on map as a trail), at an elevation of 1662 feet.

The fossils occur as scattered steinkerns.

2834. Moose River Group, Tarratine Formation, Somerset County, Maine. Southeast ninth of Long Pond Quadrangle, 0.15 mile N13E of the triangulation station on Williams Mountain, at an elevation of about 2170 feet.

The fossils occur in a shell bed.

2835. Moose River Group, Tarratine Formation, Somerset County, Maine. Southwest ninth of Brassua Lake Quadrangle, on north bank of North Branch of Misery Stream, at an elevation of about 1570 feet.

2836. Moose River Group, Tomhegan Formation, Somerset County, Maine. West ninth of Brassua Lake Quadrangle, in bed of stream which flows into Moose River west of the "*N*" in "*SANDWICH*," at an elevation of about 1320 feet.

2837. Moose River Group, Tarratine Formation, Somerset County, Maine. Southwest ninth of Brassua Lake Quadrangle, on east end of Williams Mountain on knob with elevation of 2160 feet, about 1.6 miles south of the boundary between the west and southwest quadrangle ninths and just east of the west quadrangle boundary.

The fossils occur in a shell bed.

2838. Moose River Group, Tomhegan Formation, Kineo Volcanic Member, Somerset County, Maine. Central ninth of Brassua Lake Quadrangle, 1.1 mile S38E of BM 1060, just east of stream which flows north through the east end of the Brassua Station railroad yard. The outcrops are cliffs of conglomerate.

Most of the shells are broken, a circumstance which is uncommon in this region, and suggests that this is a death assemblage.

2839. Moose River Group, Tomhegan Formation, Somerset County, Maine. Northeast ninth of Brassua Lake Quadrangle, 0.52 mile N47E from elevation 1226 (on road from Blaine School to Tenmile Swing, in dense woods).

The fossils occur as scattered shells.

2840. Moose River Group, Tomhegan Formation, Somerset County, Maine. North ninth of Brassua Lake Quadrangle, 0.95 mile S18E of Poplar Ripps, on cliff which is not well indicated on quadrangle map.

The fossils occur in thin shell beds.

2841. Moose River Group, Tomhegan Formation, Somerset County, Maine. North ninth of Brassua Lake Quadrangle, 0.22 mile east of the "*2*" in "*1200*," on the low hill east of Brassua Lake and south of Poplar Ripps.

The fossils occur as scattered shells on bedding planes.

2842. Moose River Group, Tomhegan Formation, Somerset County, Maine. Northeast ninth of Brassua Lake Quadrangle, about 0.46 mile S46W from the outlet of Baker Brook into Moosehead Lake, in dense woods at an elevation of 1135 feet.

The fossils occur as scattered shells.

2843. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of The Forks Quadrangle, about 200 feet N15W of the "*M*" in "*Cold Stream Mtn.*," at an elevation of 1760 feet.

The fossils occur as scattered shells on a bedding plane.

2844. Moose River Group, Tarratine Formation, Somerset County, Maine. South ninth of Long Pond Quadrangle, on north slope of Bean Brook Mountain, about 0.1 mile west of the "*P*" in "*PARLIN*," at an elevation of 2060 feet.

The fossils occur as scattered shells on a bedding plane.

2845. Moose River Group, Tarratine Formation, Somerset County, Maine. Northeast ninth of Pierce Pond Quadrangle, about 0.57 mile south of the "*M*" in "*STREAM*" of "*COLD STREAM MTS.*" about 100 feet southwest of small stream, at an elevation of 1620 feet.

2846. Moose River Group, Tarratine Formation, Somerset County, Maine. Northeast ninth of Pierce Pond Quadrangle, about 0.52 mile south of the "*M*" in "*MTN.*" of "*COLD STREAM MTN.*" at an elevation of about 1760 feet.

2847. Moose River Group, Tarratine Formation, Somerset County, Maine. Northeast ninth of Brassua Lake Quadrangle, on Tomhegan Point 100 feet from shore of Moosehead Lake, in front of Sperry Camp.

The fossils occur in a shell bed. This locality may be Clarke's (1909) 3457. Clarke (*idem*) in the description of the plates and in the text, lists the following species of Schoharie age from Tomhegan Point: *Prosocoelis pesanseris* var. *occidentalis*, *Amphigenia parva*, *Spirifer primaevus* var. *atlanticus*, *Spirifer perimele*, *Chonetes nectus*, *Eodevonaria hudsonicus*, *Cardiomorpha simplex*, *Prosocoelus* cf. *orbicularia*, *Rhipidomella musculosa* var. *solaris*. Examination of the figured specimens at Albany shows that their matrix is unlike any rock cropping out on Tomhegan Point, whereas it does resemble rocks to the south on Baker Brook Point. It is suggested that Clarke's fauna was collected from the Tomhegan Formation on Baker Brook Point.

2848. Seboomook Formation, Somerset County, Maine. Southwest ninth of Brassua Lake Quadrangle, on the east bank of the North Branch of Chase Stream, about 0.1 mile south of the junction of the North Branch with the small stream flowing southeast from the direction of Misery Pond, at an elevation of about 1190 feet.

The fossils occur as scattered shells.

2849. Seboomook Formation, Somerset County, Maine. Southwest ninth of Brassua Lake Quadrangle, on east bank of North Branch of Chase Stream, about 100 feet south of junction with stream coming in from direction of Misery Pond.

The fossils occur in a shell bed.

2850. Moose River Group, Tomhegan Formation, Somerset County, Maine. Southwest ninth of Brassua Lake Quadrangle, about 0.85 mile N12W of Warren Camp, at an elevation of 1615 feet in dense woods.

The fossils occur in a thin shell bed.

2851. Moose River Group, Tomhegan Formation, Somerset County, Maine. Southwest ninth of Brassua Lake Quadrangle, about 0.98 mile N2E of Warren Camp, on northwest side of 1540 foot contour, in woods.

The fossils occur as well sorted steinkerns and single valves scattered on bedding planes.

2852. Moose River Group, Tomhegan Formation, Somerset County, Maine. North ninth of Brassua Lake Quadrangle, "0.6 mile N47W from SE corner of Brassua township on S side of most prominent point near NW end of Brassua Lake. Locality is 320 feet S30E from tip of point at high water mark, and consists of several large slabs of platy, non-calc, or slightly calc. greenish to bluish gray, buff gray weathering, fine-grained sandstone. These slabs are probably very nearly in place, but are slumped so that the dip means nothing; they are aligned along the trend N45E which approximates the strike." (From Bridge and Cloud, unpublished field notes, 28 Sept. 1941, p. 102).

2853. Moose River Group, Tarratine Formation, Somerset County, Maine. Southwest ninth of Brassua Lake Quad-

rangle, on northeast bank of stream which empties into east end of 10,000 Acre Pond, at an elevation of 1500 feet.

2854. Moose River Group, Tarratine Formation, Somerset County, Maine. Southwest ninth of Brassua Lake Quadrangle, on south shore of Warren Camp Pond, about 300 feet west of the outlet.

2855. Moose River Group, Tomhegan Formation, Somerset County, Maine. Southwest ninth of Brassua Lake Quadrangle, 0.65 mile N42W of Warren Camp, at an elevation of 1600 feet.

2856. Moose River Group, Tarratine Formation, Somerset County, Maine. Southwest ninth of Brassua Lake Quadrangle, in the bed of the easternmost of the two streams that join the North Branch of Chase Stream east of Chase Stream Pond, at an elevation of 1500 feet.

2857. Seboomook Formation, Somerset County, Maine. Southwest ninth of Brassua Lake Quadrangle, 0.12 mile S29E from the outlet of Chase Stream Pond at an elevation of 1280 feet.

The fossils occur in a shell bed.

2858. Seboomook Formation, Somerset County, Maine. Southwest ninth of Brassua Lake Quadrangle, 0.65 mile N12W from Lanigan Dam, at the northeast end of the 1500 foot knob.

The fossils occur in a shell bed.

2859. Moose River Group, Tarratine Formation, Somerset County, Maine. Southwest ninth of Brassua Lake Quadrangle, on Misery Stream (for detailed location see Plate 25).

2860. Moose River Group, Tarratine Formation, Somerset County, Maine. South ninth of Brassua Lake Quadrangle, in first stream south of the *"E"* in *"MISERY"* of *"MISERY RIDGE,"* at an elevation of 1520 feet.

The fossils occur in a shell bed.

2861. Moose River Group, Tarratine Formation, Piscataquis County, Maine. Southwest ninth of North East Carry Quadrangle, in scattered outcrops on westernmost of the Moose Brook Islands.

Clarke (1909) cites this locality but gives no faunal lists. The fossils occur in shell beds.

2862. Moose River Group, Tarratine Formation, Somerset County, Maine. Southwest ninth of North East Carry Quadrangle, on west shore of Moosehead Lake N60W from northernmost building of the Folsom Farm.

This may be one of Clarke's (1909) localities 3465-3468.

The fossils occur in a shell bed.

2863. Moose River Group, Tomhegan Formation, Somerset County, Maine. Southwest ninth of North East Carry Quadrangle, on west shore of Moosehead Lake, N73W from northernmost building of the Folsom Farm.

This may be one of Clarke's (1909) localities 3465-3468.

2864. Moose River Group, Tarratine Formation, McKenney Ponds Limestone Member, Somerset County, Maine. Northwest ninth of Pierce Pond Quadrangle, on shore of McKenney Ponds north of the small island in the middle of the largest pond.

The fossils occur as scattered shells.

2865. Moose River Group, Tarratine Formation, Somerset County, Maine. Southwest ninth of Brassua Lake Quadrangle, on steep southwestern face of the knob held up by the body of garnet rhyolite cropping out on the east side of Misery Pond, about 200 feet from the shore of the pond.

The fossils occur as scattered valves on bedding planes.

2866. Moose River Group, Tomhegan Formation, Somerset County, Maine. Central ninth of Brassua Lake Quadrangle, on north slope of hill formed by anticline 0.7 mile northeast of Tarratine and about 200 yards southeast of Rte. 15 (Jackman-Rockwood road), at an elevation of 1100 feet.

2867. Moose River Group, Tomhegan Formation, Somerset County, Maine. Northeast ninth of Brassua Lake Quadrangle, in first outcrops on north bank of Moose River southwest of the bridge and extending to the southwest for about 50 feet. Outcrops are difficult to collect from except at low water.

Most of the specimens occur as steinkerns. There are more small specimens than large specimens and the best ones occur in nodules.

2868. Moose River Group, Tomhegan Formation, Somerset County, Maine. Northeast ninth of Brassua Lake Quadrangle, on north bank of Moose River about 200 feet to southwest of Loc. 2867.

2869. Moose River Group, Tomhegan Formation, Somerset County, Maine. Northeast ninth of Brassua Lake Quadrangle, on north bank of Moose River about 200 feet to southwest of Loc. 2868.

2870. Seboomook Formation, Somerset County, Maine. North ninth of Brassua Lake Quadrangle, 0.64 mile N99E of BM 1090 (near Farm Dam).

This is Williams' (1900) section 1062B, and might be either 1062B6 or 1062B7. This locality was formerly on the west bank of Brassua Stream, but due to the raising of the level of Brassua Lake it is now on the sinuous northern extension of Brassua Lake. The fossils occur in a shell bed.

2871. Moose River Group, Tomhegan Formation, Somerset County, Maine. Central ninth of Brassua Lake Quadrangle, in east side of railroad cut S61W of top of 1220 foot hill (immediately to northwest of *"T"* in *"TAUNTON"*).

2872. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Pierce Pond Quadrangle, in bed of Enchanted Stream 0.15 mile downstream from Loc. 2796, just above the trail to Little Enchanted Pond.

The fossils occur as scattered shells on bedding planes.

2873. Moose River Group, Tomhegan Formation, Somerset County, Maine. West ninth of Brassua Lake Quadrangle, on north bank of Moose River 0.02 mile west of point where Stony Brook joins Moose River.

This locality is Williams' (1900) 1061B and Clarke's (1909) locality number 3475. Revised identifications of Williams' material are: *Spirifer gaspensis* equals *"Howellella"* n. sp., *Spirifer gaspensis* large equals *Acrospirifer atlanticus*, *Chonetes antiopa* equals *Eodevonaria arcuata*, *Chonetes* cf. *mucronata* equals *"Chonetes" nectus*, *Orthis* cf. *lucia* equals *Dalejina musculosa* var. *solaris*, and the reported *Leptocoelia flabellites* probably was collected from a transported boulder. Clarke (1909) reports *Aviculopecten flammiger* and *Chonetes hudsonicus* but it is doubtful if the *Aviculopecten* is identical with that from the Tarratine Formation, and the *Chonetes* equals *E. arcuata.* The fossils occur in shell beds.

2874. Moose River Group, Tomhegan Formation, Somerset County, Maine. Southwest ninth of North East Carry Quadrangle, on west shore of Moosehead Lake N87W from the northernmost building of the Folsom Farm.

This may be Clarke's (1909) locality 3464.

2875. Moose River Group, Tarratine Formation, Somerset County, Maine. Southeast ninth of Long Pond Quadrangle, 0.35 mile N88W of the outlet of Smith Pond, at an elevation of 1545 feet.

The fossils occur as scattered valves on bedding planes.

2876. Kennebec Formation, Somerset County, Maine. East ninth of Brassua Lake Quadrangle, on southeast side of railroad (now abandoned) on west bank of west outlet of Kennebec River, about 0.11 mile southwest from the railroad overpass over the west outlet.

2877. Seboomook Formation, Somerset County, Maine. Southwest ninth of Brassua Lake Quadrangle, on northeast crest of knob south of Chase Stream Pond, at an elevation of about 1480 feet.

The fossils occur in a shell bed.

2878. Moose River Group, Tarratine Formation, Somerset County, Maine. West ninth of Brassua Lake Quadrangle, on southwest crest of knob (elevation 1600 feet) southwest of swamp on headwaters of stream which flows through the west end of the railroad yard at Brassua Station, at an elevation of about 1590 feet.

2879. Seboomook Formation, Somerset County, Maine. Northeast ninth of Brassua Lake Quadrangle, on north shore of Tomhegan Cove, on the west side of the small point north of the "*T*" in "*Tomhegan Cove.*"

The fossils occur as scattered shells.

2880. Seboomook Formation, Somerset County, Maine. East ninth of Attean Quadrangle, in village of Moose River about 200 feet east of U. S. 201 and 100 feet north of road that joins U. S. 201 at an elevation of 1187 feet.

The fossil occurred as a single valve on a bedding plane. The specimen was collected in the presence of M. P. Billings.

2881. Moose River Group, Tomhegan Formation, Kineo Volcanic Member, Somerset County, Maine. Central ninth of Brassua Lake Quadrangle, on west bank of stream that flows through the east end of the Brassua railroad yard, just below the swamp that feeds this stream at an elevation of 1270 feet.

The compressed plant material weathers out to give vertical joint surfaces a cuneiform appearance.

2882. Moose River Group, Tarratine Formation, Somerset County, Maine. South ninth of Long Pond Quadrangle, 600 feet N50W from 2540 foot hill in southwest corner of Long Pond Township.

The fossils occur as scattered shells in dark sandstone.

2883. Seboomook Formation, Somerset County, Maine. East ninth of Spencer Quadrangle, on east bank of Spencer Stream N77E from 1503 foot hill.

The fossils occur in a shell bed.

2890. Moose River Group, Tarratine Formation, Somerset County, Maine. East ninth of Spencer Quadrangle or west ninth of Pierce Pond Quadrangle, in loose boulder on Hedgehog Mountain.

The fossils occur in a shell bed.

2892. Moose River Group, Tarratine Formation, Somerset County, Maine. Southeast ninth of Long Pond Quadrangle, 0.4 mile S20W of the triangulation station on Williams Mountain, at an elevation of 2140 feet.

The fossils occur as scattered valves in rusty mudstone.

2893. Moose River Group, Tarratine Formation, Somerset County, Maine. Northeast ninth of Pierce Pond Quadrangle, on east boundary of the quadrangle and 1.7 miles south of the north boundary of the quadrangle. Coal surrounded by fibrous quartz occurs here.

2950. Hardwood Mountain Formation, Franklin County, Maine. Southwest ninth of Spencer Quadrangle, 1.5 miles S79W of the outlet of Little Jim Pond, at an elevation of 1560 feet.

The fossils occur as scattered valves in calcareous siltstone.

2955. Hardwood Mountain Formation, Somerset County, Maine. Central ninth of Attean Quadrangle, 0.85 mile N70E from the junction of Wood Stream with North Branch of Wood Stream, at an elevation of 1480 feet.

2958. Silurian undifferentiated, Piscataquis County, Maine. Southwest ninth of Moosehead Lake Quadrangle, on shore of Moosehead Lake N97E of BM1035 (along Kennebec River).

2959. Hardwood Mountain Formation, Somerset County, Maine. Northeast ninth of Spencer Quadrangle, 0.72 mile N74W of 2410 foot triangulation point, at an elevation of 1870 feet.

3015. Silurian undifferentiated, Somerset County, Maine. South ninth of Brassua Lake Quadrangle, on stream that flows southeast into Churchill Stream between the "*t*" and "*r*" in "*Stream,*" at an elevation of 1055 feet.

3085. Moose River Group, Tomhegan Formation, Somerset County, Maine. Southwest ninth of North East Carry Quadrangle, on shore of Moosehead Lake northwest of the Toe of the Boot and S36W from the westernmost of the Moose Brook Islands.

The fossils occur as steinkerns in a shell bed.

3086. Moose River Group, Tomhegan Formation, Piscataquis County, Maine. Northwest ninth of Moosehead Lake Quadrangle, on shore of Moosehead Lake, on northeast side of Kineo Tract and N7E from the triangulation station on Mt. Kineo.

3087. Moose River Group, Tomhegan Formation, Piscataquis County, Maine. Southwest ninth of North East Carry Quadrangle, on shore of Moosehead Lake north of Days Academy Grant and S19E from Center Island.

3088. Moose River Group, Tarratine Formation, Piscataquis County, Maine. South ninth of North East Carry Quadrangle, on shore of Big Duck Cove, 0.1 mile north of the outlet of the stream from Little Duck Pond that empties into Big Duck Cove.

The fossils occur in shell beds.

3089. Seboomook Formation, Somerset County, Maine. Southwest ninth of Spencer Quadrangle, on east side of top of 1860 foot hill to the northwest of Butler Pond.

The fossils occur in shell beds.

3090. Moose River Group. Tarratine Formation, Somerset County, Maine. Southeast ninth of Long Pond Quadrangle, in loose block collected at Parlin Dam on Parlin Stream.

The fossils occur in a shell bed.

3091. Seboomook Formation, Somerset County, Maine. Central ninth of Long Pond Quadrangle, on Churchill

Stream at an elevation of 1215 feet, where a small stream from the northeast joins Churchill Stream.

The fossils occur in a thin shell bed.

3092. Moose River Group, Tarratine Formation, Somerset County, Maine. South ninth of Long Pond Quadrangle, on west end of the 2580 foot knob on Bean Brook Mountain, south of the "*Br*" in "*Brook.*"

3093. Seboomook Formation, Somerset County, Maine. Southwest ninth of Spencer Quadrangle, on northwest end of Camera Hill 0.8 mile N60E from the outlet of Everett Pond, at an elevation of 1965 feet.

3094. Seboomook Formation, Somerset County, Maine. Central ninth of Long Pond Quadrangle, on south shore of Long Pond S66W from the Whipple Farm (Plate 26).

The fossil occurred as an isolated valve on a bedding plane.

3127. Hardwood Mountain Formation, Franklin County, Maine. Southwest ninth of Spencer Quadrangle, on road about opposite Little Jim Pond.

3150. Silurian undifferentiated, Piscataquis County, Maine. Southwest ninth of Moosehead Lake Quadrangle, on shore of Deer Island. N85E of BM1035 (along Kennebec River).

3225. Moose River Group, Tarratine Formation, Somerset County, Maine. North ninth of Pierce Pond Quadrangle, on Mountain Brook, about 200 feet below a beaver pond and at an elevation of 2300 feet.

The fossils occur in thin shell beds.

3226. Moose River Group, Tarratine Formation, Somerset County, Maine. North ninth of Pierce Pond Quadrangle, on the stream flowing from the small pond 0.5 mile south of the "*T*" in "*Twomile*," at an elevation of 2040 feet.

3227. Moose River Group, Tarratine Formation, Somerset County, Maine. North ninth of Pierce Pond Quadrangle, on the trail to the top of Coburn Mountain, east of the west boundary of T.2 R.6, at an elevation of 3068 feet.

3228. Moose River Group, Tarratine Formation, Somerset County, Maine. North ninth of Pierce Pond Quadrangle, on a stream that flows south into Salmon Stream, 2.94 miles N68E from the outlet of Enchanted Pond, at an elevation of 1860 feet.

3229. Seboomook Formation, Somerset County, Maine. East ninth of Spencer Quadrangle, on shore of Spencer Lake 0.6 mile to the northwest of BM 1098.

3238. Moose River Group, Tomhegan Formation, Somerset County, Maine. North ninth of Brassua Lake Quadrangle, in float from the northwest end of Brassua Lake.

3280. Lobster Mountain Volcanics, Piscataquis County, Maine. East ninth of North East Carry Quadrangle, on the south shore of Jackson Cove (Lobster Lake) N57E from BM 998.

The fossil occurred in an agglomerate.

3289. Moose River Group, Tarratine Formation, Piscataquis County, Maine. South ninth of North East Carry Quadrangle, on trail that goes along east side of Norcross Brook and across Halfway Brook to BM 1069, at an elevation of 1250 feet.

3400. Lobster Lake Formation, Piscataquis County, Maine. East ninth of North East Carry Quadrangle, on Sunset Point on Lobster Lake.

3465. Hardwood Mountain Formation, Somerset County, Maine. Central ninth of Spencer Quadrangle, in Baker Pond on a small island (not shown on quadrangle map) 0.38 mile N86W of BM 1604.

3466. Hobbstown Formation, Somerset County, Maine. Central ninth of Spencer Quadrangle, on Spencer Mountain 0.8 mile S85E of BM 1604, at an elevation of 2215 feet.

The fossils occur in angular pebbles of limestone.

3467. Hobbstown Formation, Somerset County, Maine. Central ninth of Spencer Quadrangle, in northeast corner 1.15 miles N72E from the inlet of Baker Pond, at an elevation of 1830 feet.

The fossils occurred in a limestone pebble.

3468. Hardwood Mountain Formation, Somerset County, Maine. North ninth of Spencer Quadrangle, on boundary with northeast ninth 0.05 mile north of the south boundary of the ninth.

3469. Hardwood Mountain Formation, Somerset County, Maine. North ninth of Spencer Quadrangle, 0.68 mile S60W from top of 2364 foot hill (Hardwood Mountain), at an elevation of 1925 feet.

3470. Hardwood Mountain Formation, Somerset County, Maine. North ninth of Spencer Quadrangle, 0.67 mile S75W from top of 2364 foot hill (Hardwood Mountain), at an elevation of 1920 feet.

3471. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Pierce Pond Quadrangle, 0.08 mile east of the west quadrangle boundary and 0.19 mile north of the south boundary of the northwest ninth, at an elevation of 2340 feet.

3472. Hobbstown Formation, Somerset County, Maine. North ninth of Spencer Quadrangle, in southeast corner 0.1 mile S63E from top of 2009 foot hill, at an elevation of 1900 feet.

The fossils occurred in a small boulder of calcareous slate.

3473. Hobbstown and Hardwood Mountain Formations, Somerset County, Maine. North ninth of Spencer Quadrangle on northeast side of 2009 foot hill, at an elevation of 1900 feet.

The fossils in the Hobbstown Formation were obtained from a four inch band of graywacke immediately above the disconformity with the underlying slate of the Hardwood Mountain Formation. The fossils in the Hobbstown Formation occur in a shell bed; those in the Hardwood Mountain Formation are scattered through layers of slate. Associated with the Hobbstown fossils are poorly rounded pebbles of granite.

3474. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Pierce Pond Quadrangle, 0.09 mile east of the west quadrangle boundary and 0.32 mile north of the south boundary of the northeast ninth.

3475. Lime-silicate hornfels of Late Llandovery age, Somerset County, Maine. Northeast ninth of Stratton Quadrangle, on south end of highest knob of Limestone Hill, S87W from BM 2497 (Flagstaff Mountain), at an elevation of 1960 feet.

3476. Moose River Group, Tarratine Formation, Somerset County, Maine. Northeast ninth of Spencer Quadrangle, 0.12 mile west of the east quadrangle boundary and 0.08 mile north of the south boundary of the northeast ninth, at an elevation of about 2400 feet.

3477. Parker Bog Formation, Somerset County, Maine. West ninth of Pierce Pond Quadrangle, 0.87 mile S48E from the outlet of Heald Pond, in a swampy area just south of a small stream flowing into the Parker Bog Ponds just north of the *"P"* in *"PONDS."*

3478. Moose River Group, Tarratine Formation, Somerset County, Maine. West ninth of Pierce Pond Quadrangle, 0.45 mile N82E from the outlet of Heald Pond, at an elevation of 1360 feet.

3479. Hobbstown Formation, Somerset County, Maine. Same as Loc. 3473.

3481. Seboomook Formation, Somerset County, Maine. East ninth of Spencer Quadrangle, east of stream flowing into Lost Pond 0.7 mile S53W of top of 1912 foot hill, at an elevation of 1810 feet.

3482. Seboomook Formation, Somerset County, Maine. Southwest ninth of Spencer Quadrangle, 0.7 mile N31E of the outlet of Little Jim Pond, at an elevation of 1780 feet.

The fossils occur in shell beds.

3483. Hardwood Mountain Formation, Somerset County, Maine. West ninth of Spencer Quadrangle, west of Whit Brook, 0.84 mile N31E of BM 1350, at an elevation of 1400 feet.

3484. Hardwood Mountain Formation, Franklin County, Maine. Southwest ninth of Chain Lakes Quadrangle, on east boundary of the ninth, on shore of Jim Pond 1.33 miles north of the south boundary of the northeast ninth.

3485. Hardwood Mountain Formation, Franklin County, Maine. Southwest ninth of Spencer Quadrangle, on east side of north lobe of Jim Pond, S69W of elevation 1585 (on road that runs west of Little Jim Pond).

3486. Seboomook Formation, Somerset County, Maine. South ninth of Spencer Quadrangle, on south bank of Spencer Stream at elevation 1294.

3487. Parker Bog Formation, Somerset County, Maine. Southeast ninth of Spencer Quadrangle, on south bank of Spencer Stream 0.28 mile N76E of BM 1271.

3488. Hardwood Mountain Formation, Somerset County, Maine. Central ninth of Spencer Quadrangle, on east shore of Baker Pond N94E from the outlet of Davis Pond.

The fossils occur in loose slabs of limestone on the shore of the lake. A trench, five feet in depth, was dug but firm bedrock was not reached, although the general impression of this occurrence is that of a deeply weathered exposure in which frost action has loosened the myriad cleavage fragments.

3495. Hardwood Mountain Formation, Somerset County, Maine. Central ninth of Spencer Quadrangle, on the west Branch of Spencer Stream midway between the 1360 foot and 1380 foot contours.

3496. Hardwood Mountain Formation, Somerset County, Maine. Central ninth of Spencer Quadrangle, on the West Branch of Spencer Stream 0.14 mile upstream from the 1320 foot contour.

3497. Beck Pond Limestone, Somerset County, Maine. Central ninth of Spencer Quadrangle, 0.12 mile N81W of the inlet of Beck Pond, at an elevation of 1780 feet.

3498. Hobbstown Formation, Somerset County, Maine. Southwest ninth of Spencer Quadrangle, on the ridge northwest of Camera Hill 0.6 mile N2E of the outlet of Everett Pond, at an elevation of 2005 feet.

The fossils occur in limestone pebbles.

3499. Beck Pond Limestone, Somerset County, Maine. Central ninth of Spencer Quadrangle, on trail that crosses the outlet stream of Beck Pond 0.1 mile south of the pond, just west of the stream at an elevation of 1740 feet.

3600. Beck Pond Limestone, Somerset County, Maine, Central ninth of Spencer Quadrangle, 200 feet south of Loc. 3601.

3601. Beck Pond Limestone, Somerset County, Maine. Central ninth of Spencer Quadrangle, on trail that runs from Spencer Lake south of Beck Pond to east shore of King and Bartlett Lake, 0.23 mile west of Loc. 3499, at an elevation of 1860 feet.

4000. Moose River Group, Tarratine Formation, Somerset County, Maine. Northwest ninth of Pierce Pond Quadrangle, 1.02 miles S18W from the outlet of Little Enchanted Pond.

4001. Moose River Group, Tarratine Formation, Somerset County, Maine. West ninth of Pierce Pond Quadrangle, on southeast side of Hedgehog Mountain, 0.4 mile east of the west boundary of Upper Enchanted Township, at an elevation of 2560 feet.

4002. Moose River Group, Tarratine Formation, Somerset County, Maine. East ninth of Spencer Quadrangle, 1.51 miles S47E from the top of 2040-foot hill, at an elevation of 2340 feet.

4003. Moose River Group, Tarratine Formation, Somerset County, Maine. East ninth of Spencer Quadrangle, 0.32 mile N48E from top of 1650 foot hill (east of Spencer Lake), at an elevation of slightly over 1700 feet.

4004. Moose River Group, Tarratine Formation, Somerset County, Maine. East ninth of Spencer Quadrangle, 0.97 mile N65E from top of 1650 foot hill, at an elevation of 1880 feet.

4005. Moose River Group, Tarratine Formation, Somerset County, Maine. East ninth of Spencer Quadrangle, on first stream emptying into Spencer Lake northeast of the outlet of the lake, at an elevation of 1270 feet.

4006. Moose River Group, Tarratine Formation, Somerset County, Maine. East ninth of Spencer Quadrangle, 1.1 miles S48E from BM 1098 (at outlet of Spencer Lake), on top of 1340 foot knob.

4007. Moose River Group, Tarratine Formation, Somerset County, Maine. West ninth of Pierce Pond Quadrangle, 0.47 mile N76E from the outlet of Heald Pond, at an elevation of 1325 feet.

4008. Moose River Group, Tarratine Formation, Somerset County, Maine. West ninth of Pierce Pond Quadrangle, 0.68 mile N20E from the outlet of Heald Pond, at an elevation of 1600 feet.

4009. Moose River Group, Tarratine Formation, Somerset County, Maine. West ninth of Pierce Pond Quadrangle, 0.76 mile N21E from the outlet of Heald Pond, at an elevation of 1760 feet.

4010. Seboomook Formation, Somerset County, Maine. South ninth of Spencer Quadrangle, on south bank of Spencer Stream, 0.08 mile upstream from Spencer Dam.

4011. Hobbstown Formation, Somerset County, Maine. Southwest ninth of Spencer Quadrangle, 0.4 mile N12E from the outlet of Everett Pond, at an elevation of 1880 feet.

4012. Seboomook Formation, Somerset County, Maine. Southwest ninth of Spencer Lake Quadrangle, on southwest side of Camera Hill 0.8 mile N66E from the outlet of Everett Pond, at an elevation of 1960 feet.

4013. Moose River Group, Tomhegan Formation, Somerset County, Maine. Southwest ninth of North East Carry Quadrangle, on the shore of Moosehead Lake northwest of the Toe of the Boot, S36W of the westernmost of the Moose Brook Islands.

4014. Hardwood Mountain Formation, Somerset County, Maine. Central ninth of Attean Quadrangle, 1.02 miles N37E from the point where Wood Stream enters Little Big Wood Pond, at an elevation of 1480 feet.

4015. Hardwood Mountain Formation, Somerset County, Maine. North ninth of Spencer Quadrangle, 0.06 mile west of the east boundary of the ninth and 0.16 mile north of the south boundary of the ninth, at an elevation of 1915 feet.

4016. Hardwood Mountain Formation, Somerset County, Maine. Central ninth of Spencer Quadrangle, 0.02 mile south of the north boundary of the ninth and 0.12 mile west of the east boundary of the ninth at an elevation of 1860 feet.

4017. Moose River Group, Tarratine Formation, Piscataquis County, Maine. South ninth of North East Carry Quadrangle, 0.18 mile N53W of the top of 1400 foot hill (east of Little Duck Cove), at an elevation of 1350 feet.

DATE DUE
GORHAM CAMPUS

OCT 13 1983

FEB 9 1989

FEB 16 1984

APR 10 1984

MAR 16 1989

MAY 8 1992