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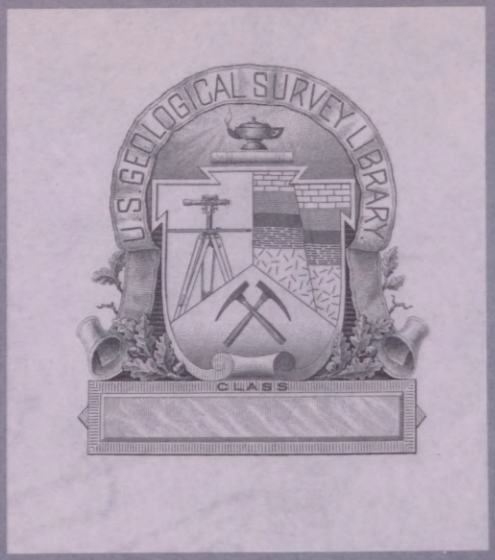
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GEOLOGY OF THE ARNOLD POND QUADRANGLE

OXFORD AND FRANKLIN COUNTIES, MAINE

By

David S. Harwood, 1936 -

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Geology of the Arnold Pond quadrangle
Oxford and Franklin Counties, Maine

by David S. Harwood

INTRODUCTION

The Arnold Pond quadrangle lies on the northwest limb of the Boundary Mountain anticlinorium (Albee, 1961), a major northeast-trending fold that extends across northern New Hampshire, west-central Maine and adjacent Quebec. The anticlinorium is defined in a regional sense by the Taconic unconformity separating pre-Silurian rocks from the rocks of Silurian and Devonian age. In the western part of the Arnold Pond quadrangle this unconformity is folded and locally faulted. Within the anticlinorium is a thick and highly folded sequence of green salte and quartzite, black slate, mafic and felsic volcanic rocks, and graywacke dated in part as late Middle Ordovician (Harwood and Berry, 1967). These pre-Silurian rocks are flanked to the northwest by calcareous slate and limestone, thin lenses of conglomerate, and well-bedded slate and quartzite of Late Silurian to Early Devonian age. Because the complete section of rocks in the anticlinorium is not exposed in the Arnold Pond quadrangle, the interested reader is referred to the work of Hatch (1963) and Green (1964; in press) in northern New Hampshire; Albee and Boudette (in ~~preparation~~ press), Boucot and others, (1964), Harwood (1966), and Harwood and Berry, (1967) in west-central Maine; and Marleau (1957; 1959) in adjacent Quebec.

STRATIGRAPHY

Dixville Formation

South of the Arnold Pond quadrangle the Dixville Formation (Green, 1964) has been divided into a lower part consisting primarily of black slate with patches of greenstone, and an upper part that is predominantly feldspathic graywacke with lenses of green, purple and black slate, felsite, and patches of greenstone. The upper part of the Dixville, named the Magalloway member by Green (in press), has been mapped continuously from the type area to the Arnold Pond quadrangle (Harwood, 1966).

In addition to the Magalloway member, the greenstone, laminated felsite and slate, and graywacke in the northwest part of the quadrangle are also included in the Dixville Formation and considered to be pre-Silurian in age. This interpretation is made because: 1) they underlie green and red slate near Abbie Pond here considered to be Silurian or Devonian in age, 2) they are lithologically similar to the greenstone, black slate, and graywacke of the Dixville Formation in the Cupsuptic area (Harwood, 1966), and 3) they are intruded by serpentinite bodies that are characteristically found in pre-Silurian rocks in the Northern Appalachians but, as yet, have not been found intruding rocks of known Silurian or Devonian age. This interpretation is contrary to that made by Marleau (1959) and Green (in press) who consider this belt of greenstone and related rocks to be equivalent to greenstones in the Frontenac Formation (Marleau, 1957) and thus of Silurian or Devonian age.

The age of the Dixville Formation must be pre-Late Silurian because fossiliferous limestone of Ludlow age rests unconformably on the Dixville east of Lower Black Pond and in the west-central part of the Cupsuptic quadrangle (Harwood and Berry, 1967). Through correlations across the strike and along the strike of the anticlinorium, Harwood and Berry (1967) tentatively dated the Dixville as Middle Ordovician; an age consistent with the data in the Arnold Pond quadrangle.

Black slate, amphibolite, and orthoquartzite

Black sulfidic slate and interbedded feldspathic and sulfidic quartzite, amphibolite, quartz granule conglomerate, orthoquartzite and gray slate occur in thin septa in the quartz monzonite north and south of Arnold Pond. The sequence of units, pieced together from scattered septa, appears to be interbedded black slate and amphibolite grading upward into quartz granule conglomerate and locally massive orthoquartzite or gray slate. The conglomerate and orthoquartzite grade upward into well-bedded orthoquartzite and gray slate that in turn is overlain, along a sharp but intensely folded contact, by rusty black slate, feldspathic quartzite and minor amphibolite. The rock units appear to be conformable and, with the exception noted above, their contacts are gradational. The black slate and feldspathic quartzite is about 250 feet thick and contains amphibolite layers about 50 feet thick. The conglomerate and orthoquartzite lenses are at most 50 feet thick and the well-bedded orthoquartzite and slate unit is about 150 feet thick.

The age of this sequence of rocks is not known. Because it appears to overlie and possibly interfinger with the biotite gneiss of the Magalloway member it is probably Middle Ordovician or younger. In this part of the northern Appalachians most of the fossils that have been found in black slate and volcanic rocks associated with serpentinites are pre-Silurian, and most commonly Middle Ordovician, in age. Quartz-pebble conglomerate, orthoquartzite and well-bedded quartzite and gray pelite, however, characteristically carry Silurian or Devonian fossils, if any. Because the quartz conglomerate and well-bedded rocks are conformably interlayered with rocks most reasonably considered to be Ordovician, the entire sequence is tentatively considered to be Ordovician(?). Additional data, either from fossils or from distinctly unconformable attitudes between the rusty slate and orthoquartzite, may come from the Chain Lakes quadrangle. Such data may indicate that these two sequences should be considered separately; the rusty slate, amphibolite, and serpentinite being pre-Silurian, the orthoquartzite and gray pelite being Silurian or Devonian.

Calcareous slate and limestone

Gray calcareous slate containing discontinuous patches of dark gray, coarsely crystalline limestone and limestone "edgewise" conglomerate rests unconformably above the Magalloway member of the Dixville Formation in the western part of the quadrangle. Although the actual unconformity was not observed due to glacial cover the trend of the calcareous slate truncates the trend of a thin greenstone lens in the Magalloway member about ½ mile south of the quadrangle. The calcareous slate is about 500 feet thick; the limestone lenses range from 10 to 50 feet thick.

Naylor and Boucot (1965, p. 161, locality 19) tentatively dated the limestone in this unit as Ludlow(?) (Late Silurian).

Green slate and siltstone, red slate, and felsic tuff

A thin, resistant layer of white to gray-green felsic tuff conformably overlies the calcareous slate and limestone unit on the limbs of a small syncline southeast of Lower Black Pond. Locally on the east limb of the syncline the felsic tuff is overlain by maroon to brick-red slate that grades laterally into green slate and calcareous siltstone. To the west, near Upper Black Pond, red slate with thin siltstone beds and layers 1 to 6 inches thick of white felsic tuff locally separates green slate and siltstone from mafic volcanic rocks assigned to the Dixville Formation. The contact between the red and green slate is conformable and gradational. The contact between the red slate and greenstone and the green slate and greenstone is interpreted to be an unconformity but because bedding was not seen in the greenstone at the contact, the unconformable relationships cannot be unequivocally established.

The felsic tuff east of Lower Black Pond is about 100 feet thick and the red slate found locally above the tuff ranges in thickness from 0 to 200 feet. The green slate and siltstone unit that is about 3000 feet thick west of Deer Brook consists of about 150 feet of green slate, tuff and calcareous siltstone immediately east of Lower Black Pond.

No fossils have yet been found in the green slate and siltstone, red slate, and felsic tuff unit, but because it overlies the calcareous slate and limestone unit of Ludlow(?) age it can be no older than Late Silurian. East of Lower Black Pond this unit conformably underlies the Seboomook Formation (Boucot, 1961) of Early Devonian age. Thus the green slate and siltstone, red slate, and felsic tuff unit is considered to be Late Silurian to Early Devonian in age and may be correlative with the Lobster Lake Formation and possible the Capens Formation in the Moose River Synclinorium (Boucot, 1961).

Seboomook Formation

Well-bedded, dark-gray slate and feldspathic quartzite that overlie the green slate and siltstone, red slate and felsic tuff unit east of Deer Brook is assigned to the Seboomook Formation (Boucot, 1961) of Early Devonian age. This correlation, made on lithologic similarity, agrees with the general distribution of the Seboomook Formation shown by Boucot and others (1964) and is compatible with the Late Silurian age tentatively established for the underlying calcareous slate and limestone.

The stratigraphic relations between the Seboomook and the green slate and siltstone unit are unknown because of the scarcity of outcrop in and near Deer Brook. The Seboomook conformably overlies the red slate unit and the felsic tuff unit east of marker 460 on the international boundary, and the green slate and siltstone unit near the outlet to Lower Black Pond. If these thin units are equivalent in part to the red slate and the green slate and siltstone units west of Deer Brook, as proposed here, then the Seboomook Formation at least in part overlies and may be in part a lithofacies of the green slate and siltstone unit. The Seboomook Formation is about 3000 feet thick east of Deer Brook. This figure is comparable to the thickness of the green slate and siltstone unit to the west.

INTRUSIVE ROCKS

Serpentinite, granodiorite, and quartz monzonite plutons and mafic dikes ranging in age from Late Ordovician(?) to Triassic(?) intrude the metasedimentary rocks in both parts of the quadrangle and comprise most of the bedrock in the eastern part.

Serpentinite

Serpentinite and serpentinized periodite and pyroxenite intrude rocks inferred to be of Middle Ordovician age in both parts of the quadrangle. Because these serpentinized ultramafic rocks do not intrude known Silurian or Devonian strata, nor do any other serpentinite bodies elsewhere in the northern Appalachians, it is assumed they are of Late Ordovician age. This age assignment assumes that the rocks at Twin Peaks are, in fact, part of the Dixville Formation and not the Frontenac Formation of Devonian age as proposed by Marleau (1959) and Green (in press). If Marleau and Green are correct then the serpentinite at McKie Fork and the small bodies on strike to the north and south are the first known serpentinites of Devonian or younger age in the northern Appalachians.

Granodiorite, quartz monzonite, and intrusive felsite

The large bodies of granodiorite and quartz monzonite in the eastern part of the quadrangle are believed to represent a comagmatic differentiated intrusive separated by a transition zone that is gradational in composition between the two rock types. Although detailed chemical studies that would undoubtedly support or refute this hypothesis have not been made as yet, several field relationships suggest that the bodies are essentially contemporaneous differentiates. Neither the quartz monzonite nor the granodiorite is extensively metamorphosed although both show local alteration on joint surfaces where biotite and hornblende are replaced by chlorite and the feldspars are sericitized. No dikes of one body cut the other even though abundant dikes of quartz monzonite, aplite, and pegmatite cut the country rock adjacent to the quartz monzonite body. In addition to these macroscopic relationships, the biotite-rich quartz monzonite contains scattered microscopic grains of hornblende and sphene which are major constituents of the granodiorite.

The intrusive felsite is found only in the western part of the quadrangle and has a modal composition very similar to that of the quartz monzonite (Harwood, 1966, p. 123).

Mafic dikes

Dark-green to black unmetamorphosed mafic dikes as much as 15 feet thick intrude the Magalloway member and the biotite-muscovite quartz monzonite. The dikes in Massachusetts Bog Stream and north of Arnold Pond have a narrow chilled border against the quartz monzonite. Because the dikes cut the quartz monzonite that is considered to be of Devonian age, they are clearly post-Devonian and are tentatively dated as Triassic(?).

STRUCTURE

The structural interpretation of the western part of the quadrangle depends, in large measure, on the age of the greenstone, laminated felsite and slate, and graywacke exposed at Twin Peaks. If these rocks are Middle Ordovician (or older) as proposed in this report, the Seboomook and underlying rocks of Silurian or Devonian age form a narrow but possibly extensive syncline in west-central Maine, northern New Hampshire and adjacent Quebec. In this interpretation the serpentinite at McKie Fork would lie roughly on the axial trace of a narrow anticline between the syncline proposed above and the Frontenac synclinorium to the northwest shown by Marleau (1959) and Albee (1961). If the rocks at Twin Peaks are in an anticline the axial trace of the Frontenac synclinorium would have to be shifted about a mile further northwest than shown by Marleau and would most logically lie between the thin greenstone lenses within the Frontenac and Gile Mountain sedimentary rocks as shown by Hatch (1963) to the southwest. The extent of these major folds in the Taconic unconformity and overlying rocks is not known, but they may continue north to Scotch Cap Mountain in Quebec (about 12 miles) and south to the Dixville Notch area (about 25 miles).

As a consequence of this interpretation the mafic volcanic member of the Kidderville Formation of Hatch (1963) and Green (in press) would most logically be correlated with the rock at Twin Peaks and thus be Ordovician in age not Devonian as originally proposed. If this interpretation is correct, the greenstone on the southeast limb of the Frontenac synclinorium would then be the thin lenses in the Gile Mountain Formation as mapped by Hatch (1963) and their equivalents in the Frontenac Formation to the north and not the Kidderville mafic volcanics as shown by Green (in press).

The alternative hypothesis, proposed by Hatch (1963) and Green (in press) requires that the greenstone, felsite and slate, and graywacke at Twin Peaks here included in the Dixville Formation overlie the green slate and siltstone and the Seboomook Formation and thus be of Devonian age. The rocks in the northwest part of the map area would thus represent an essentially homoclinal sequence on the southeast limb of the Frontenac synclinorium. This interpretation is apparently inconsistent with the minor structures at Abbie Pond and Upper Black Pond as well as the regional observation that serpentinite intrudes pre-Silurian metasediments ary rocks not Silurian or Devonian rocks. If the greenstone is Devonian then the green slate and siltstone must have been thrust to the west and the greenstone exposed in a window at Abbie Pond. There is no evidence to support northwest thrusting, in fact, the orientation of the axial planes of minor folds and the axial plane cleavage suggests that the area was deformed by stresses with a west over east movement sense.

The structure in the eastern part of the quadrangle is difficult to determine because the tops of beds in the Magalloway member cannot be determined. Large recumbent minor folds are present in the biotite gneiss of the Magalloway member north of Rock Pond and west of the outlet to Massachusetts Bog Stream but there are no marker beds by which these structures can be defined or traced out. This recumbent folding may be a local feature adjacent to the intrusive bodies or, when data ~~is~~ are available to the east, it may prove to be a widespread form of deformation. The black slate, amphibolite and quartzite unit appears to be conformably above the Magalloway member and may lie in the trough of a small northwest-trending syncline.

ECONOMIC RESOURCES

The thin veinlets of slip-fiber and minor amounts of cross fiber asbestos in the McKie Fork serpentinite body constitute a possible future source of asbestos. The small serpentinite bodies north and south of Arnold Pond contain fewer veinlets of asbestos than the body at McKie Fork.

Galena has been found in the amphibolite associated with the serpentinite immediately north of Arnold Pond and in float blocks beside the road to Arnold Bog in Quebec about 0.6 mile northwest of the outlet of Arnold Bog (L. R. Page, personal communication, 1967).

Although no mineralization was found along the fault southeast of Lower Black Pond several small chacopyrite shows have been found on strike along the east slope of Thrasher Peaks in the Cupsuptic quadrangle south of Rump Pond in the Second Lake quadrangle.

Sand and gravel in outwash and esker deposits are abundant in the low areas underlain by quartz monzonite and granodiorite in the eastern part of the quadrangle.

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