The Putnam Group of Eastern Connecticut

By H. ROBERTA DIXON

CONTRIBUTIONS TO STRATIGRAPHY

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THE PUTNAM GROUP OF EASTERN CONNECTICUT

By H. Roberta Dixon

ABSTRACT

The Putnam Gneiss of eastern Connecticut is redefined as the Putnam Group, made up of two formations. The Quinebaug Formation is composed primarily of metavolcanic rocks and is overlain by the Tatnic Hill Formation, a series of metasedimentary rocks. The base of the Quinebaug Formation is cut off by a major north-trending fault.

INTRODUCTION

The Putnam Gneiss of eastern Connecticut is here redefined as the Putnam Group, composed of an upper metasedimentary unit, here called the Tatnic Hill Formation, and a lower metavolcanic unit, here called the Quinebaug Formation. Both formations have been separated into several members on the basis of lithology. The work on which this paper is based was done in cooperation with the Connecticut Geological and Natural History Survey.

PUTNAM GROUP

The Putnam Group is a heterogeneous unit of high-grade metamorphic rocks that underlies a large part of eastern Connecticut and consists of a wide variety of mica schists and gneisses, hornblende schists and gneisses, amphibolites, calc-silicate gneisses, and minor amounts of marble, dolomite, and quartzite. These rocks were recognized as a distinct unit by Mather (1834), Percival (1842), Gregory (in Rice and Gregory, 1906), Loughlin (1912), Foye (1949), and Rodgers and others (1959); and, except for local variations, the boundaries shown for the unit are essentially the same on all of their maps. The name Putnam Gneiss was assigned to the rocks by Gregory (in Rice and Gregory, 1906) for the town of Putnam, most of which is underlain by rocks of this unit. Loughlin (1912) and Foye (1949) included the Plainfield Quartz Schist (of Gregory, in Rice and Gregory, 1906) as a member of the Putnam Gneiss; however, recent work has shown that the Plainfield is older than the rocks of the Putnam Group and is, in part at least, separated from them by a major fault. Detailed subdivision of the Putnam Gneiss was not attempted until recent work in the area, of which the Norwich quadrangle by G. L. Snyder (1961) is the only map published so far. The Norwich quadrangle is underlain primarily by the upper part of the Putnam Gneiss, which is thus equivalent to the Tatnic Hill Formation; Snyder recognized six lithologic units within these rocks.

The rocks of the Putnam Group can be traced northward into Massachusetts where the Tatnic Hill Formation is apparently correlative with the Nashoba Formation, and the Quinebaug Formation, with the Marlboro Formation (Hansen, 1956). To the south the Putnam Group is cut off by the Honey Hill fault (Snyder, 1961; Lundgren and others, 1958). On the east the Quinebaug Formation is truncated by a major north-trending fault that may be an extension of the Honey Hill fault, though the connection between the two faults has not yet been mapped. On the west the Tatnic Hill Formation is overlain by the Hebron Formation. No fossils have been found in eastern Connecticut, and the rocks of the Putnam Group cannot be dated by direct evidence. Previous estimates of the age of the rocks range from Precambrian to Carboniferous. Present indications are that the Putnam Group is certainly pre-Pennsylvanian and probably early Paleozoic in age.

The bulk of the rocks in the Putnam Group are apparently in the sillimanite-muscovite and sillimanite-potassium feldspar grades of metamorphism. Only on the extreme western edge of the Tatnic Hill Formation are rocks of staurolite-kyanite grade present. The Quinebaug Formation is commonly low in aluminum silicates, but metamorphic minerals include hornblende, diopside, and scapolite; and it is probable that the rocks are in the sillimanite grade. To the east and south, near the Honey Hill fault, the rocks have apparently been downgraded by cataclasis.

TATNIC HILL FORMATION

The Tatnic Hill Formation is here named for exposures in the area of Tatnic Hill in the southern part of the Danielson quadrangle (fig. 1), where the section is more complete and contacts are better exposed than elsewhere. The type area consists of a series of outcrops extending from Connecticut Route 169, on the east side of Tatnic Hill, west for 2½ miles to Stetson Road, in the southeast corner of the Hampton quadrangle. The contact between the Tatnic

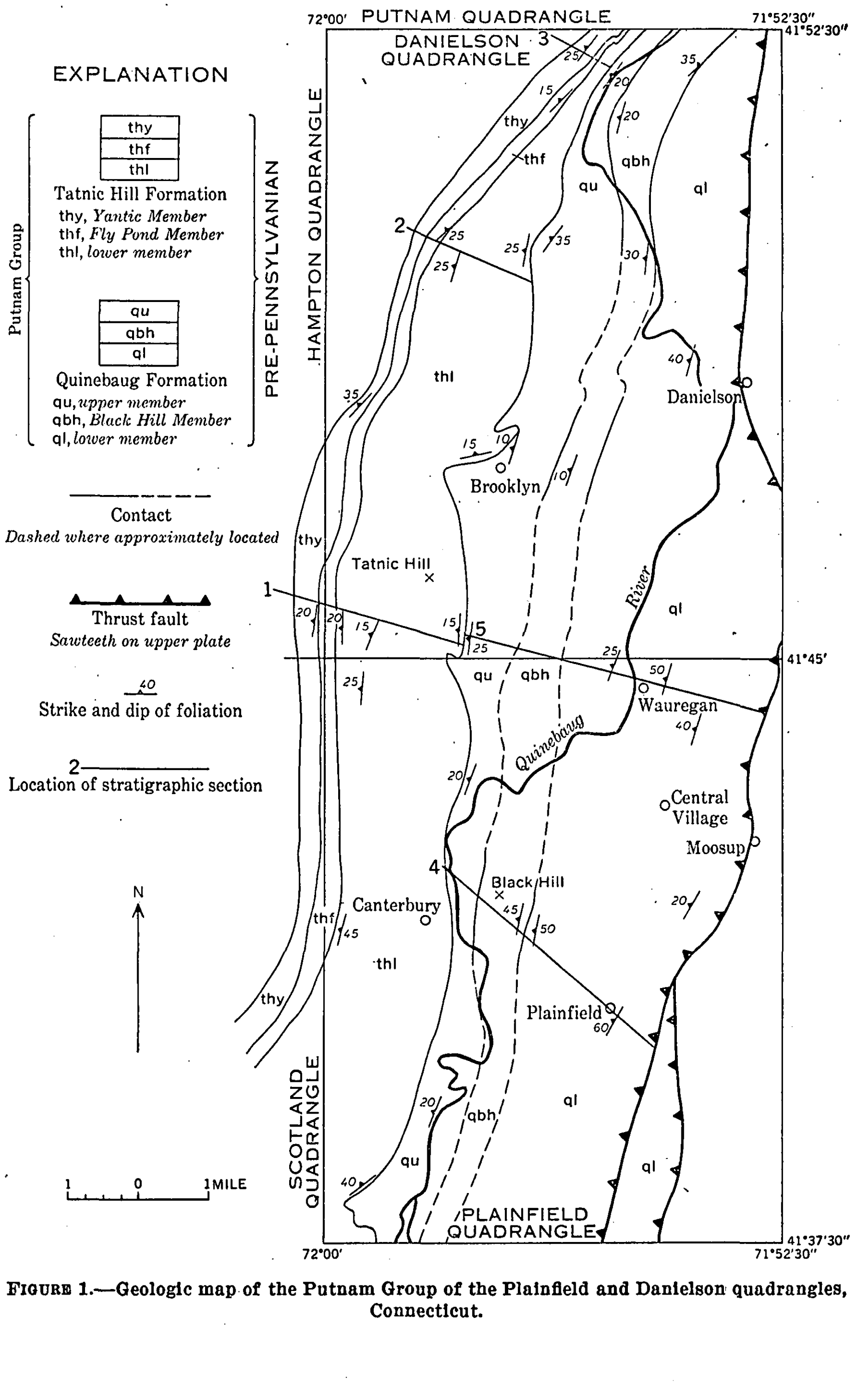

FIGURE 1.—Geologic map of the Putnam Group of the Plainfield and Danielson quadrangles, Connecticut.

Hill Formation and the underlying Quinebaug Formation is exposed on the hill slope 80–100 feet above Route 169. The contact with the overlying Hebron Formation is not exposed in this area, but it must be near the base of the hill west of Stetson Road. The total thickness of the formation in the Tatnic Hill area is about 5,550 feet (section 1, fig. 2). Two named members have been mapped in the Tatnic Hill area—the Yantic Member at the top of the formation and, immediately underlying it, the Fly Pond Member. Beneath the Fly Pond the lower member of the Tatnic Hill Formation has been subdivided into three main lithologic units which are gradational into each other and between which no sharp contacts can be drawn. The Bates Pond Lentil, which Snyder (1961) mapped as a lens in the Putnam Gneiss in the Norwich quadrangle, would be in the lower member of the Tatnic Hill Formation and is apparently of only local extent for it does not occur to the north. Pegmatitic and granitic dikes and sills of varying sizes and compositions occur throughout the formation, but they are in general largest and most abundant in the Yantic and Fly Pond Members.

The name Yantic was informally used by Snyder in the Norwich area (written commun., 1958) to distinguish the youngest rocks of the Putnam Gneiss from rocks of similar composition lower in the sequence. This is a useful distinction to make, and the Yantic Member is here named as the upper unit of the Tatnic Hill Formation. The name was informally assigned by Snyder for exposures near the village of Yantic in the Norwich quadrangle, where the Yantic Member forms the western belt of Snyder's biotite-muscovite schist. The type locality for the Yantic in the Tatnic Hill area is from the boundary between the Hampton and Danielson quadrangles, west to Stetson Road. Here it has a thickness of about 1,250 feet (section 1, fig. 2), though it contains numerous pegmatitic sills and dikes that probably account for about 300 feet of the total thickness. The unit has a minimum thickness of 500 feet about 5 miles north of the Tatnic Hill area and a maximum thickness of about 2,500 feet in the Norwich quadrangle, where there is probably some tectonic thickening.

The Yantic Member is predominantly a dark-gray medium-grained porphyroblastic muscovite-biotite-oligoclase-quartz schist.[1] Oligoclase occurs in the ground mass and porphyroblasts as much as half an inch in diameter. Garnet is rare, but locally abundant, and may form prophyroblasts more than an inch in diameter. Interlayered with the schist are medium-gray fine-grained biotite-oligoclase-quartz schist and medium-grained slightly rusty weathering aluminum sili-

[1] In this report, rock names have minerals listed in a general order of abundance, the least abundant mineral given first. Minerals shown in parentheses are not always present in a given rock type.

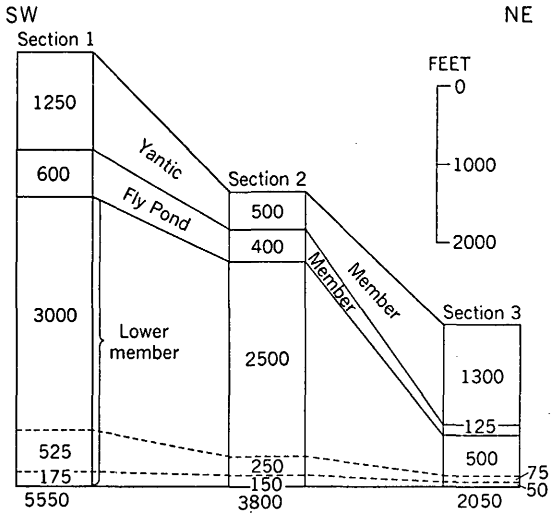

FIGURE 2.—Stratigraphic sections in the Tatnic Hill Formation showing variation in thickness. Location of sections is shown in figure 1. Dotted lines are lithologic boundaries described in text.

cate-garnet-biotite-muscovite-oligoclase-quartz schist. In these rocks the aluminum silicate is kyanite and (or) staurolite on the west side of the Yantic Member and sillimanite on the east side. Pods of medium-grained layered amphibolite that average about 10–20 feet long and about 5 feet thick are common near the contact with the underlying Fly Pond Member.

The contact between the Yantic Member and the overlying Hebron Formation is commonly on a dip slope and is poorly exposed. The only known exposure of the contact is in the northern part of the Danielson quadrangle on the west side of Wolf Den Brook and 0.6 mile due east of the Putnam Wolf Den. Here the contact is marked by a gradational zone about 2 feet thick separating the porphyroblastic mica schist of the Yantic Member from the fine-grained calcite-hornblende-biotite-andesine-quarzt schist of the Hebron Formation. The rocks in the transition zone are more siliceous than the rocks above and below and are mainly interlayered fine-grained granulite and mica-quartz schist. The outcrop is too small to allow determination of whether the contact is conformable or unconformable.

The Fly Pond Member was named by Snyder (1961) for exposures near Fly Pond in the northern part of the Norwich quadrangle. It is a nonresistant calcareous rock and, except where cut by abundant pegmatites, commonly forms valleys. In the Tatnic Hill area the Fly Pond Member is about 600 feet thick, including about 200 feet of pegmatite. This general thickness is relatively consistent to the south, though in the Norwich quadrangle Snyder (1961) showed a rapid local thinning to 150 feet. To the north the unit thins, and at the north edge of the Danielson quadrangle it is about 125 feet thick, of which about half is pegmatite.

The Fly Pond Member is dominantly a medium-grainted light- to medium-gray diopside-hornblende-epidote-biotite-quartz-andesine gneiss. Locally lenses of mica schist or of sillimanite-biotite schist from 5 to 25 feet thick are interlayered with the calcareous gneiss. Snyder (1961) mapped an area of marble in the Fly Pond Member of the Norwich area. Marble has not been found to the north; but it may, though unexposed, underlie some of the valleys there.

The contact between the Fly Pond Member and the overlying Yantic Member is fairly well exposed and is sharp, although in most places pegmatite occurs at the actual contact. The amphibolite near the base of the Yantic Member commonly makes the contact easy to locate even where it is not actually exposed. The lower contact of the Fly Pond Member is poorly exposed; but west of Tatnic Hill, pegmatites extend into the lower part of the member and preserve exposures of the calcareous gneiss to within about 10 feet stratigraphically of the underlying gneiss. The contact apparently is sharp. Where the contact is most closely approached, the calcareous gneiss is underlain by about 5 feet of medium-grained biotite-plagioclase-quartz schist that grades rapidly into the sillimanite-bearing gneiss below.

The lower member of the Tatnic Hill Formation makes up two-thirds of the unit. It is a thick sequence of gneisses in which the degree of deformation—including folding, faulting, local zones of granulation, and general grade of metamorphism—increases to the east (toward the base) and to the south toward the Honey Hill fault. In the Tatnic Hill area the sequence is about 3,700 feet thick, but it thickens to the south and thins to the north. A thickness of at least 20,000 feet in the southern part of the Norwich quadrangle can be calculated from Snyder's map; but this area is close to the Honey Hill fault, and the thickness is surely exaggerated by folding and faulting. The member thins to 600 feet at the north edge of the Danielson quadrangle. Evidence from older maps and reconnaissance suggests that it thickens again north of Putnam (just north of the map area of fig. 1). The effect of folding and faulting on the variation in thickness is difficult to estimate. Small-scale folds (that is, having amplitudes of inches to several feet) and faults can be observed in many outcrops and must have some effect on the total thickness. However, except for the Yantic Member, all units in the formation thin to the north; and the thinning is believed to be primary, at least in part.

Three main lithologic units can be recognized in the lower member of the Tatnic Hill Formation throughout the Plainfield and Danielson quadrangles. These units are not separated in figure 1, mostly because of the scale of the map, but the divisions are shown in the columnar sections of figure 2. South of this area a fourth unit, which lenses out in the western part of the Plainfield quadrangle, has been mapped directly under the Fly Pond Member. This unit is Snyder's eastern belt of biotite-muscovite schist—a dark-gray medium-grained muscovite-biotite-oligoclase-quartz schist—in general similar to the schist of the Yantic Member. The thickest unit in the lower member is a sillimanite-bearing gneiss that makes up about 80 percent of the member (in the Tatnic Hill area it is about 3,000 ft of the total thickness of 3,700 ft). In the Norwich area these rocks are represented primarily by Snyder's (1961) sillimanite-pinite schist, though some of his biotite gneiss, biotite-muscovite schist, and amphibolite probably would be included also. In this unit the rock is primarily a medium-grained dark-gray to dark-greenish-gray sillimanite-garnet-(muscovite)-biotite-quartz-oligoclase gneiss alternating with fine-grained nonsillimanitic and less micaceous gneiss in layers 4–12 inches thick. Sillimanite may be present as fresh needles, but more commonly it has been altered to dark-green sericite pods, which characterize the rock. Muscovite-biotite-(garnet)-oligoclase-quartz gneiss and biotite-garnet-oligoclase-quartz gneiss, commonly containing feldspar porphyroblasts, are locally interlayered with the sillimanite gneiss. A few miles south of Tatnic Hill a thin belt (maximum thickness of 250 ft) of calcsilicate gneiss, similar to that of the Fly Pond Member, can be traced for about 5 miles mostly within the sillimanite gneiss. Many of the rocks in this belt as well as those immediately above and below it show fairly strong granulation and may represent a slice of the Fly Pond Member repeated by faulting. However, the belt is more likely a depositional unit at a lower stratigraphic level than the Fly Pond Member.

The sillimanite gneiss grades downward into a heterogeneous assemblage of rocks that are in general characterized by an abundance of garnet. In the Tatnic Hill area this unit forms a belt about 550 feet thick beneath the sillimanite gneiss. Similar rocks may occur locally within the sillimanite gneiss. In the Norwich area these rocks are represented primarily by Snyder's (1961) biotite gneiss plus some pods of the sillimanite-pinite gneiss, graphite schist and amphibolite, and also apparently the Bates Pond Lentil, though this rock has not been found north of the southern part of the Norwich quadrangle. The most common rock in this unit (probably about 50 percent of the unit) is a poorly layered dark-gray medium-grained porphyroblastic garnet-biotite-oligoclase-quartz gneiss. Other rock types include sillimanits - (kyanite) - biotite - garnet - orthoclase-oligoclase-quartz gneiss, light-reddish-gray (sillimanits)-quartz-o l i g d c l a s e-garnet gneiss, a rusty-weathering (biotite)-muscovite-sillimanite-garnet-quartz schist, medium-gray calc-silicate gneiss and amphibolite. Porphyroblasts of plagioclase and garnet are common in many of these rocks, and porphyroblasts of pink orthoclase as much as 1 inch in diameter are distinctive but less common.

The rusty-weathering schist and the amphibolite increase in abundance in the lower part of the garnet gneiss unit and become the main rock types in the basal unit of the Tatnic Hill Formation. Locally the rusty schist thickens and may make up most of the garnet gneiss unit, as in the village of Canterbury where the rusty schist appears to be a metamorphosed conglomerate interlayered with amphibolite. Here it has an apparent thickness of more than 500 feet, but it thins rapidly north and south of the village. At the base the Tatnic Hill Formation is marked by a persistent belt of a distinctive rusty-weathering graphite-muscovite-(kyanite)-silimanite-garnet-quartz schist that ranges in thickness from 50 to 175 feet. Pods of amphibolite are commonly associated with the rusty schist and probably make up about 25 percent of the basal unit.

QUINEBAUG FORMATION

The name Quinebaug Formation is here given to a thick sequence of metamorphosed volcanic and sedimentary rocks directly underlying the basal rusty-weathering schist of the Tatnic Hill Formation. It is named for the Quinebaug River which, in the Plainfield and Danielson quadrangles, flows only over rocks of this unit and which courses from the top to the lowermost exposed rocks of the formation. Because of incomplete exposure, no one type locality can be given for the unit as a whole, but localities for the respective members will be designated in the discussion of each member.

The uppermost part of the Quinebaug Formation is well exposed in steep east-facing cliffs, and the contact with the overlying Tatnic Hill Formation is at or near the top of these cliffs. The base of the formation is not present in this area, as the lowermost rocks are in fault contact with the underlying alaskite gneiss and quartzite. How much of the Quinebaug Formation is cut out by the fault cannot be determined until the formation is studied in an unfaulted area. Present evidence suggests that the displacement may be relatively small in this area but that it increases to the north, so that in southern Massachusetts the Quinebaug Formation is almost, if not entirely, cut out.

The Quinebaug Formation can be divided into three members: the upper and the lower are primarily metavolcanic rocks, and the middle, the Black Hill Member, metasedimentary rocks. Only the top of the formation (the upper 100–150 ft) and, in the Plainfield quadrangle, the cataclased basal rocks are consistently well exposed. Estimates of the thickness of the formation are hazardous, both because of the general poor exposure and because structural complications become more abundant near the fault. The two sections shown in figure 3 were measured across the areas of most complete exposure (about 20 percent) and show a maximum thickness of about 7,000 feet for the Quinebaug above the fault. In the northern part of the Danielson quadrangle, an approximate maximum thickness of 5,000 feet is suggested, but the only exposed contact here is the top of the formation. The actual thickness of the unit, especially in the Plainfield quadrangle and in the southern part of the Danielson quadrangle, may be considerably less than the figures given, as there may be some repetition of units across a possible fold in the lower part of the Quinebaug Formation.

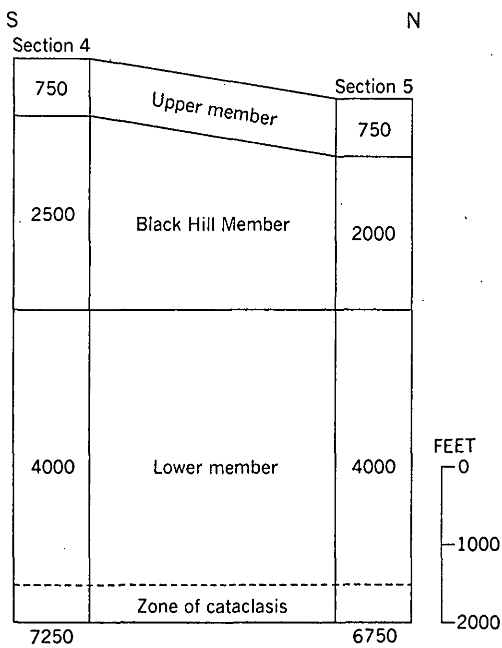

FIGURE 3.—Stratigraphic sections in the Quinebaug Formation showing variation in thickness. Location of sections is shown in figure 1.

Exposures of the upper member of the Quinebaug are largely restricted to the uppermost 100–150 feet. A typical exposure is on the east slope of Tatnic Hill, along the west side of State Route 169, where 120 feet of the upper unit forms a steep cliff capped by the rusty-weathering schist of the Tatnic Hill Formation. The unit has an apparent thickness of 750–1,000 feet throughout much of the area, but in the northern part of the Danielson quadrangle it thins to about 300 feet. The lower contact with the Black Hill Member is not exposed in the area studied.

The rocks of the upper part of the Quinebaug Formation are well-layered dark- to medium-gray fine- to medium-grained hornblende schists and gneisses. Individual layers average 2–3 inches thick and range in thickness from thin laminae to more than 1 foot. About 50 percent of the unit is dark-gray (hornblende)-epidote-biotite-quartz-plagioclase schist, commonly containing plagioclase porphyroblasts and less commonly containing garnet. The most distinctive rock is a light-gray to brownish-gray fine- to medium-grained quartz-epidote-biotite-hornblende-plagioclase gneiss containing porphyroblasts of hornblende and plagioclase. Other rocks include layered amphibolite, (hornblende)-biotite-quartz-plagioclase granulite, biotite-quartz-plagioclase schist, and minor calc-silicate granulite. Amphibolite pods and epidote pods are common throughout the unit.

The Black Hill Member is composed of a series of metasedimentary rocks, most of them calcareous, and is in general a poorly exposed nonresistant unit. It is here named for exposures on the southern end of Black Hill, which is east of the Quinebaug River and just north of State Route 14A (formerly Route 14). Across Black Hill the unit has a maximum thickness of about 2,500 feet, but the rocks are strongly folded, and the true thickness is probably less than the figure given. Rock types are different, however, on the east and west sides of the hill.

On the west side of Black Hill the rocks are well-bedded medium-gray fine- to medium-grained (garnet)-muscovite-biotite-quartz schist and minor yellow muscovite-quartz schist interlayed or interfolded with dark-gray fine-grained (muscovite)-calcite-hornblende-quartz-biotite-oligoclase schist. Outside of the Black Hill area these are the main rock types that are exposed. On the east side of the hill the rock is primarily light-greenish-gray fine- to medium-grained calcite-muscovite-plagioclase-quartz granulite but has interlayed rocks containing scapolite, diopside, hornblend, and biotite. Mafic minerals increase in abundance near the base of the unit, and the rocks grade rapidly into the hornblende gneiss and amphibolite of the lower part of the Quinebaug Formation. In figure 1 the contacts of the Black Hill Member are dashed where the unit has been projected through areas of no exposure, though its presence is locally inferred by boulders in the glacial drift. To the south, in the Jewett City quadrangle, Sclar (1958) and Loughlin (1912) reported lenses of dolomite in the Putnam Gneiss that are on general strike trend from the Black Hill area. A reconnaissance in the area to the south indicated that the dolomite is associated with a dark-gray calcite-biotite schist similar to the rock on Black Hill. In the northern part of the Danielson quadrangle, a fine- to medium-grained light-gray biotite-muscovite-quartz-feldspar gneiss is interlayered with the calcite-biotite schist. This rock may be an intrusive sill, or it may represent interbedded felsic volcanic rocks.

Between the Black Hill Member and the fault is a lower member mainly of metavolcanic rocks that shows increasingly severe cataclasis toward its base. The sequence has a maximum thickness of 4,000 feet in the Plainfield quadrangle, if one assumes no structural exaggeration, and thins to the north; north of Danielson, however, exposures are too poor for an estimation of thickness. Type exposures of the upper part of this member are just east of Black Hill, on either side of Route 14; and the lower part is exposed on a series of hills between Central Village and Wauregan. In general the rock types are similar to those of the upper member of the Quinebaug Formation, though garnet is more abundant and biotite is less abundant than is common in the upper member. The most common rocks are medium- to dark-gray medium-grained garnet-biotite-epidote-quartz-plagioclase gneiss and medium-gray medium-grained (biotite)-epidote quartz-hornblende-plagioclase gneiss, with interlayered amphibolite (which is locally the dominant rock type), fine-grained biotite-quartz-plagioclase granulite ranging to a medium-grained gneiss, and calc-silicate granulite. Shearing and granulation are only locally apparent megascopically in the rocks to within 500 feet stratigraphically above the fault. However, in the lower half of the unit, cataclastic effects are microscopically evident to varying degrees in most of the rocks.

The lower 500 feet of the exposed Quinebaug Formation is made up of cataclasites of different types. They consist of intermixed fine-grained biotite-hornblende-epidote-quartz-plagioclase granulites; porphyroclastic (hornblende)-biotite-epidote-plagioclase-potassium feldspar-quartz augen gneiss; and, along the fault itself, very fine grained mylonite and phyllonite. These rocks, though distinctive, cannot be said to characterize the formation.

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