Some Suggested Stratigraphic Relations in Part of Southwestern New England

GEOLOGICAL SURVEY BULLETIN 1380

Prepared in cooperation with the Massachusetts Department of Public Works

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By NORMAN L. HATCH, JR., *and* ROLFE S. STANLEY

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A facies change and a new Ordovician formation in southwest Massachusetts are described, and correlations between western Massachusetts and Connecticut are suggested

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SOME SUGGESTED STRATIGRAPHIC RELATIONS IN PART OF SOUTHWESTERN NEW ENGLAND

By NORMAN L. HATCH, JR., and ROLFE S. STANLEY

ABSTRACT

Part of the U.S. Geological Survey mapping program in Massachusetts has been directed toward tracing the Paleozoic stratigraphy of the east limb of the Green Mountain massif of Vermont south across Massachusetts to tie in with recent mapping in the eastern part of western Connecticut.

The Hoosac Formation, the Rowe Schist, and the Moretown, Hawley, and Goshen Formations have been traced southward across Massachusetts to the vicinity of Blandford, Mass. The Hoosac, Rowe, and Moretown continue south of Blandford, but the Hawley undergoes a major change of facies. Six kilometers north of Blandford it is predominantly black carbonaceous schist and quartzite. Between that point and Blandford village these rocks intertongue laterally with brown and gray noncarbonaceous well-bedded thinly bedded pelitic schist and granular schist herein named the thin-bedded member of the Cobble Mountain Formation. Three kilometers northeast of Blandford, coarser grained, spangly micaceous and feldspathic schists appear as a thick-bedded member of the Cobble Mountain Formation above the thin-bedded member. The overlying Goshen Formation and the Russell Mountain Formation pass under the Triassic cover a few kilometers north of the south edge of the Woronoco quadrangle.

In addition to the detailed mapping of the Collinsville quadrangle by Stanley, we have done extensive reconnaissance mapping in the area between the Blandford and Woronoco quadrangles and Westport, Conn. On the basis of this reconnaissance, we have proposed extensive revisions of the stratigraphic sequences in many of the quadrangles involved.

In the West Granville, Southwick, New Hartford, and Tariffville quadrangles mapped by R. W. Schnabel, we suggest that rocks mapped as Unit 5 are the Goshen Formation and are the youngest unit in the section; we correlate Unit 4 inside the domes with much of Units 7 and 8 outside the domes.

Similarily, we suggest that The Straits Schist of the Collinsville area is the youngest unit and correlative with the Goshen Formation of Massachusetts. The Straits is underlain by a series of gneisses in the cores of the domes that are facies equivalent to the upper part of the predominantly schistose sequence of units west of the domes.

In the Torrington, Thomaston, and Waterbury quadrangles mapped by C. W. Martin, R. M. Cassie, and R. M. Gates, we equate most of the rocks mapped as The Straits, as well as Southington Mountain, to the Goshen of Massachusetts. We exclude from the Goshen, however, the belt of The Straits

that has been mapped northward from Thomaston into Unit II of the Hartland Formation in the Torrington quadrangle because we believe that Unit II is approximately correlative with the Rowe Schist. The Hitchcock Lake, Reynolds Bridge, and part of Hartland Unit III are approximately Hawley correlatives, whereas Hartland Unit I is approximately Moretown. The Waterbury Gneiss probably includes rocks whose ages range from that of the Rowe to that of the Hawley.

In the Southington, Mount Carmel, Ansonia, and Milford quadrangles mapped by C. E. Fritts, we have correlated almost all the Straits Schist and some Southington Mountain Schist with the Goshen, whereas we have considered the Wepawaug an eastern facies of the Straits. We have also proposed that much of the Derby Hill Schist is sheared Wepawaug along a fault that we have named the East Derby fault. Most of the Southington Mountain we consider Hawley correlative and generally stratigraphically above the Prospect and Waterbury Gneisses and equivalent to or above the Hitchcock Lake. The Derby Hill in the southern and southeastern parts of Fritts' area is equivalent to the Moretown.

In the Naugatuck quadrangle mapped by M. H. Carr, The Straits is Goshen in age and the Orange Phyllite is equivalent to the Wepawaug. The Prospect Gneiss and the remaining units of Carr's Hartland Formation, in our opinion, are all pre-Silurian, probably Middle Ordovician, in age.

In the Long Hill and Bridgeport quadrangles mapped by W. P. Crowley, we interpret the lower member of The Straits Schist, the upper member of The Straits Schist in the northern part of his area, the Cooks Pond, and Crowley's staurolite schist member of the Southington Mountain as Goshen. The rest of the upper member of The Straits Schist and the Southington Mountain plus the Trap Falls and Collinsville are probably Middle Ordovician and overlie the Newtown Gneiss and the Prospect and Orange Formations of Crowley which are also probably Middle Ordovician in age.

In the eastern part of the Westport quadrangle mapped by J. H. Dieterich, The Straits is Goshen and overlies the Fairfield and Prospect Formations. We generally agree with Dieterich's stratigraphic sequence.

Throughout this whole belt, lenses of marble, amphibolite, calc-silicate granulite, and quartzite have been mapped along the boundary between rocks that we consider to be Goshen in age and rocks that we consider to be pre-Silurian in age. We propose that these lenses are a southward continuation of the Russell Mountain Formation of southern Massachusetts.

Our interpretation of the stratigraphy indicates that the Goshen equivalents in western Connecticut occupy highly contorted isoclinal synclines that are refolded by the rise of the Granville, Granby, Collinsville, Bristol, and Waterbury domes.

INTRODUCTION

The general sequence and approximate ages of the Paleozoic stratified rocks on the east limb of the Green Mountain massif in Vermont were established in the 1950's. This work has been summarized on the "Centennial Geologic Map of Vermont" by Doll, Cady, Thompson, and Billings (1961).

The Precambrian core of the Green Mountain massif of Vermont extends about 2 km (kilometers) into western Massachusetts (pl. 1). Eight km to the southeast, Precambrian rocks crop out again and extend southward as the core of the Berkshire massif across Massachusetts and 25 km into northwestern Connecticut (pl. 1).

The rocks on the east limb of the Berkshire massif in Massachusetts were studied and mapped in the 1880's by Emerson (1898a, b). He divided these rocks into the following formations, listed in order of decreasing age, which he traced across Massachusetts to Connecticut: Hoosac Schist, Rowe Schist, Chester Amphibolite, Savoy Schist, Hawley Schist, Goshen Schist, and Conway Schist.

Mapping in western Connecticut since the late 1940's has delineated units of metasedimentary and metavolcanic rocks east of and presumably stratigraphically and structurally above the Precambrian rocks of southwestern New England. These metamorphic rocks are a southward extension of the rocks mapped by Emerson in Massachusetts, which, in turn, extend northward into eastern Vermont. Understandably then, recent workers in western Connecticut have tried to correlate the rocks there with the established eastern Vermont sequence of Doll, Cady, Thompson, and Billings (1961). Unfortunately, however, despite repeated efforts (for example Fritts, 1962; Stanley, 1964, p. 43–50), no really satisfactory correlation has been devised.

In order to solve this problem, among others, the U.S. Geological Survey directed part of its cooperative mapping program with the State of Massachusetts toward tracing the rocks of the eastern Vermont sequence southward across western Massachusetts by 1:24,000-scale quadrangle mapping. This work was started by A. H. Chidester (Chidester and others, 1967) in 1961 and P. H. Osberg (Osberg and others, 1971) in 1962 and has been continued by Hatch (Hatch and Hartshorn, 1968; Hatch, 1969; Hatch, Norton, and Clark, 1970) with considerable assistance from S. A. Norton, S. F. Clark, Jr., and R. G. Clark, Jr., in the block of quadrangles from lat 42°45′ N. to 42°07′30″ N. and from long 72°45′ W. to 73°00′ W. R. W. Schnabel has been mapping the area immediately to the south in northernmost Connecticut and southernmost Massachusetts.

Stanley mapped the Collinsville quadrangle, Connecticut (Stanley, 1964; pl. 1, this report) and subdivided the rocks there into a sequence of formations and members. He then began mapping about 30 km to the north, southeast of Blandford village in the southern part of the Blandford and Woronoco quadrangles, Massachusetts (pl. 1), where he recognized many similar rocks in the same sequence as those in the Collinsville area.

In the early 1960's, reconnaissance mapping in Massachusetts clearly indicated that the major units established in the northernmost part of the State (Chidester and others, 1967; Hatch, 1968a; Hatch and Hartshorn, 1968) could be traced southward to the vicinity of the village of Blandford, Mass., (pl. 1). Just south of Blandford, many of the rocks looked generally familiar, but their thicknesses and, in particular, their unfamiliar sequence made correlation difficult with the established formations to the north. Stanley's (1964) mapping in the Collinsville area and around Cobble Mountain Reservoir southeast of Blandford (Stanley, 1967) suggested that the Collinsville rocks could be traced north to within a few kilometers of Blandford. The answer to our longstanding north-south correlation problems thus appeared to be a stratigraphic or structural complication in the immediate vicinity of the village of Blandford. In the summer of 1969 the authors jointly mapped the critical areas in the Blandford and Woronoco quadrangles. This work provided an explanation for the apparent discontinuity in the Blandford area and enabled us to propose a correlation of the stratified rocks of west-central Connecticut with the rocks of northern Massachusetts and southeastern Vermont. This report presents some of the results of our detailed study at Blandford and of our reconnaissance studies to the south.

The first part of this report summarizes the stratigraphy of the rocks that have been traced south from the Massachusetts-Vermont State line to lat 42°07′30″, with particular emphasis on a major facies change in the vicinity of Blandford, Mass. The second part of this report discusses stratigraphic sections in southern Massachusetts and western Connecticut. Many of these sections involve stratigraphic names that may not necessarily follow the nomenclature in use by the U.S. Geological Survey but to which we repeatedly refer throughout this report.

ACKNOWLEDGMENTS

In addition to the considerable help in the field mapping in Massachusetts by A. H. Chidester, P. H. Osberg, S. A. Norton, S. F. Clark, Jr., and R. G. Clark, Jr., we are indebted to S. F. Clark, Jr., John Rodgers of Yale University, L. M. Hall of the University of Massachusetts, and D. S. Harwood for the time and thought they devoted to discussion with us of the results presented below and for their constructive reviews of earlier versions of this report. H. E. Simpson kindly gave us permission to include on plate 1 some unpublished contacts in the Bristol quadrangle, Connecticut. Although the contacts are his, we take full responsibility for the interpretation. We would particularly like to acknowledge the thoughtful help and cooperation of R. W. Schnabel,

who, although he does not necessarily agree with many of the ideas presented here, gave his time freely to lead us through his area and discuss the problems with us.

STRATIGRAPHIC SECTION OF WESTERN MASSACHUSETTS

The Paleozoic rocks of the eastern Vermont sequence extend into Massachusetts where they have previously been divided into six formations. Their descriptions, definitions, and correlations with the Vermont sequence have been presented elsewhere (Hatch and others, 1966; Hatch, 1967; Hatch, Stanley, and Clark, 1970; Hatch and Stanley, 1970) and are summarized here only insofar as they pertain to the present north-south facies and correlation problems. A seventh formation is formally introduced and described below. The distribution of these formations in the area studied in Massachusetts is shown on plate. 1.

HOOSAC FORMATION

The Hoosac Formation in the northern part of Massachusetts is primarily medium-grained gray or gray-brown quartz-albite-biotite gneiss or schist characterized by distinctive, commonly black, megacrysts of albite. Texturally similar, slightly rusty and more aluminous quartz-biotite-muscovite-chlorite-garnet gneiss and schist are present but less abundant. Southward, these more aluminous rocks gradually increase in abundance and locally form mappable units (Norton, 1967; 1971a). West and southwest of Blandford, Mass., the aluminous rocks form about 50 percent of the formation.

ROWE SCHIST

The Rowe Schist (Hatch and others, 1966) consists of green muscovite-quartz-chlorite schist, gray carbonaceous muscovite-quartz-biotite schist, and dark-green amphibolite. These three rock types form a series of thin discontinuous beds and lenses, and any one type may predominate at a given locality. The most distinctive and unique rock type, the one that predominates throughout most of Massachusetts, is the green muscovite-quartz-chlorite schist. Carbonaceous schist immediately underlies green schist across at least the southern 15 km of our Massachusetts study area. For reasons of scale, these subdivisions of the Rowe are not shown on plate 1.

At the Vermont-Massachusetts State line, the Rowe Schist is about 300 m (meters) thick (Hatch and Hartshorn, 1968); about 270 m is amphibolite and the remaining 30 m is carbonaceous

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schist and green muscovite-quartz-chlorite-(garnet)-magnetite schist. A few miles to the southwest, the formation is 100 m thick, the amphibolite has pinched out, and the green schist predominates, with minor carbonaceous schist (Chidester and others, 1967). A few miles to the southwest again, in the vicinity of the east portal of Hoosac Tunnel (Chidester and others, 1967; Herz, 1961), the Rowe abruptly thickens to about 1,600 m and consists mostly of green schist with many thin mappable units of amphibolite and carbonaceous schist. South from Hoosac Tunnel to the latitude of Blandford village (pl. 1), the Rowe maintains a fairly constant thickness of about 1,500 m (if outcrop width in near-vertical beds can be assumed to approximate thickness). Throughout this distance, the green schist forms about 50 to 75 percent of the formation and contains abundant garnet, kyanite, and staurolite south of the Chester quadrangle. Carbonaceous schist forms a major mappable unit at the base of the formation that is generally about 300–600 m thick (Norton, 1967; Osberg and others, 1971; Hatch, 1969; Hatch, Norton, and Clark, 1970; Hatch and Stanley, unpub. data) and is continuous throughout all but a few kilometers of the Rowe outcrop belt between Hoosac Tunnel and Blandford. The Chester Amphibolite Member of the Rowe, about 600 m thick at Chester Village, and many other mapped and unmapped bodies of amphibolite a few meters to a few hundred meters thick, make up the rest of the formation in this interval.

Southeast from the latitude of Blandford, the green schist unit of the Rowe thins gradually, and at the south boundary of the Blandford quadrangle the Rowe has a thickness of about 450 m. Of this thickness the upper 60 m or less is green schist, and the rest is carbonaceous schist which, by a gradual southward coarsening of texture and increase in such minerals as garnet and staurolite, can only be distinguished from the underlying Hoosac schist by the presence of traces of carbonaceous material.

MORETOWN FORMATION

The fine-grained pinstriped quartz-plagioclase-biotite granulite and schist of the Moretown Formation are continuous southward from Vermont. These rocks formed most of Emerson's (1898a) Savoy Schist. South from Charlemont village (pl. 1), the formation thins gradually from an outcrop width (beds are everywhere vertical or nearly so, although internal folding is complex) of 6,000 m to about 1,500 m west of Blandford village, but the mineralogy, texture, and overall character of the rock remain essentially unchanged. A nubbly garnet schist unit of approximately equal parts pinstriped granulite, fine-grained hornblende-plagioclase amphibolite, and a conspicuous garnetiferous mica schist is present (but not distinguished on pl. 1) at the top of the formation south from the Vermont State line to the south edge of the Chester quadrangle. Southwest and south of Blandford village, the formation continues to thin coincident with a gradual increase in fine-grained muscovite and the consequent development of a more schistose, rather than granulose, character of much of the rock.

HAWLEY FORMATION

At the Vermont-Massachusetts State line, the Hawley Formation (Hatch, 1967) is about 1,500 m thick, of which the upper 600 m are interbedded carbonaceous sulfidic rusty-weathered schist and quartzite and plagioclase-hornblende-chlorite-epidote gneiss (Skehan, 1961; Hatch and Hartshorn, 1968). The lower 900 m are assorted felsic and mafic metavolcanic gneiss and schist. Southwest and south to the vicinity of the Deerfield River, the carbonaceous metasedimentary rocks thin to an aggregate thicknes of about 20 m, the metavolcanic rocks thicken, and the whole formation thickens to an outcrop width of 3,700 m and thus a probable stratigraphic thickness of about 3,000 m or slightly more (see section 1 of the stratigraphic sections).

South from the Deerfield River, the Hawley Formation thins to about 200 m a few kilometers southwest of Worthington. Here the formation consists of about 25 m of carbonaceous schist, quartzite, and coticule rock (very fine grained quartz-garnet-granulite) under and overlain by plagioclase- and hornblende-rich gneiss.

About 10 km south of Worthington, the Hawley thickens southward with a simultaneous increase in the proportion of metasedimentary to metavolcanic rocks (Hatch, Norton, and Clark, 1970). At the northern edge of the Blandford quadrangle (pl. 1), metavolcanic rocks constitute only 27 percent of the total formational thickness of about 2,250 m (see section 2).

About 6 km north of the village of Blandford (fig. 1), an even more striking change takes place in the rocks of the Hawley Formation. The sulfidic carbonaceous gray and black schist and quartzite pass laterally, in a series of long tongues, over a distance of 5 or 6 km, into a sequence of thinly interbedded nonsulfidic noncarbonaceous fine- to medium-grained light-brown to gray-brown quartz-muscovite-biotite-garnet schist and granulite. These rocks were previously given the informal field designation of 4TB by Stanley (1967) where he mapped them around Cobble Mountain Reservoir (fig. 1). The northernmost occurrence of these brown schists is near the top of the Hawley section. To the south they are progressively lower in the formation (fig. 1), and at Blandford village they form the entire stratigraphic interval.

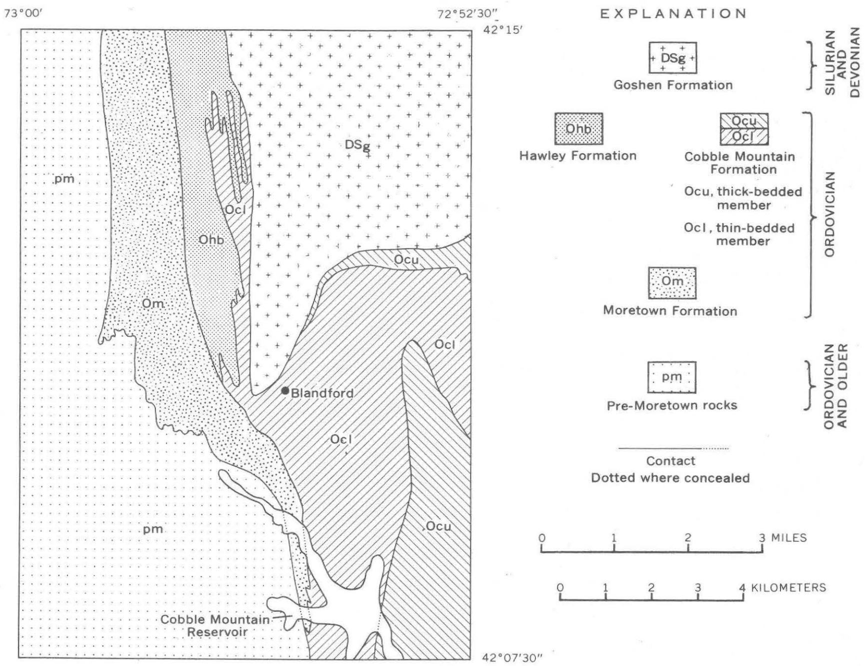

FIGURE 1.—Generalized geologic map of the Bradford quadrangle, Massachusetts, showing the relation between the Hawley Formation and the two members of the Cobble Mountain Formation. Ocu and Ocl here are equivalent to Ohcu and Ohcl on plate 1.

The intertonguing of the carbonaceous and noncarbonaceous rocks is evident at the scale of figure 1; in addition, many outcrops in the area north of Blandford show layers or lenses of the two rock types intercalated on a scale of a few millimeters, a few centimeters, or a few meters. Furthermore, in the same area, rocks were observed that are intermediate in texture and color between the very fine-grained black carbonaceous schist typical of the Hawley and the coarser grained sandy-textured brown noncarbonaceous schist of Stanley's (1967) 4TB rock unit. Thus, the change from Hawley to Stanley's 4TB type rocks takes place by a combination of intertonguing and gradation.

East and south of Blandford, another unit appears above Stanley's (1967) 4TB unit and thickens to the south (fig. 1). This unit, which consists largely of medium- to coarse-grained nonrusty silvery-gray noncarbonaceous schist, gneiss, and granulite, was earlier given the informal field designation of unit 5 (Stanley 1967).

COBBLE MOUNTAIN FORMATION

The name Cobble Mountain Formation is here assigned to all rocks previously designated by Stanley (1967) as unit 4TB and 5 and to their northward extension north of Blandford village. It also includes approximately the upper 200 m of 4rm as mapped by Stanley in 1967. Excellent exposures of this formation are found around and near the eastern shores of Cobble Mountain Reservoir in the southeastern part of the Blandford, Massachusetts 7½-minute quadrangle (fig. 1). The type area is along and near the southeastern shores of Cobble Mountain Reservoir and includes outcrops along Cobble Mountain Road and the point of land that extends northward into the reservoir 2.3 km west of the southeast corner of the Blandford quadrangle. Most of the rock types in the two members of the Cobble Mountain Formation are well exposed in this area.

The Cobble Mountain Formation is divided into a thin-bedded member and a thick-bedded member which correspond in large part to units 4TB and 5 of Stanley (1967). Each of these members has been further subdivided into mappable subunits which can be traced throughout much of the southern part of the Blandford and Woronoco quadrangles. Because the southward extent of the two members is not precisely known, formal member names are not now being proposed.

THIN-BEDDED MEMBER

The thin-bedded member, which forms the lower part of the formation, consists of two dominant map units. Red-rusty-weathering schist forms the lower part of the member south of Blandford, and thin-bedded granulite and schist that underlie much of the southeastern quarter of the Blandford quadrangle form a more extensive upper unit of this member. The red-rusty-weathering schist, which is not exposed in the type area for the formation, is best seen along the transmission line east of Falls Road in Blandford (about 1 km south of Blandford village, pl. 1).

The lower unit of the thin-bedded member is distinctive red-rusty-weathered quartz-muscovite-biotite-plagioclase-garnet schist with thin beds, 5–10 cm (centimeters) thick, of white quartz-plagioclase granulite and thinner layers, about 1 cm thick, of glassy quartzite. Gray layers and laminae of fine-grained muscovite and carbonaceous material are present at several places in the unit. Some rusty layers are stained yellow by weathering of pyrite. Kyanite-garnet and kyanite-garnet-staurolite are minor assemblages in the red-rusty-weathered schist. Beds or lenses of massive hornblende-plagioclase amphibolite less than 1 m thick occur throughout the unit, and a distinctive hornblende-anthophyllite amphibolite was found at two localities near the contact with the thin-bedded granulite and schist unit. The red-rusty schist was previously mapped with 4rm (Moretown Formation of this study) by Stanley (1967) but is now included in the thin-bedded member of the Cobble Mountain Formation because it contains graphitic schist, glassy quartzite, and anthophyllite amphibolite that are characteristic of the carbonaceous schist and quartzite unit of the Hawley Formation in the northern part of the Blandford quadrangle.

The upper or thin-bedded granulite and schist unit of the thin-bedded member of the Cobble Mountain Formation is made up of light-brown or gray-brown mica-quartz-plagioclase-garnet-staurolite schist interlayered with light-brown fine-grained quartz-plagioclase-mica granulite and gneiss in beds commonly less than 15 cm thick. Thin beds of garnet-staurolite schist alternate with thin beds of granulite, producing in some places a coarse striped pattern. Kyanite and (or) sillimanite is commonly associated with garnet and staurolite in the schist. Thick beds of amphibolite appear to be more numerous at the type locality than to the north. Beds of carbonate-free calc-silicate, feldspar-rich hornblende gneiss (felsic to intermediate metavolcanic rocks), coticule, and cummingtonite schist are rare. Many of the beds show excellent grading. At five localities along the contact with the thick-bedded member, graded beds indicate that the thick-bedded member is younger than the thin-bedded member. The thin beds, the light-brown to gray-brown color of the granulose and schistose rocks, the distinctive fine-grained granulites, and the clarity of the graded beds are the key features that distinguish the thin-bedded member from the other mapped units in the Cobble Mountain Formation and from other units in the Blandford quadrangle.

THICK-BEDDED MEMBER

The thick-bedded member of the Cobble Mountain Formation consists of three principal rock units: silvery-gray nonrusty-weathering feldspathic gneiss and schist which compose the main body of the member, a rusty schist with subordinate thin beds of quartz-plagioclase gneiss, and aluminous schist which is only present locally in the upper part of the formation.

The feldspathic gneiss and schist unit consists of nonrusty-weathering silvery-gray mica-plagioclase-quartz schist commonly interlayered with beds of medium- to coarse-grained plagioclase-quartz-mica gneiss 15–40 cm thick. Sillimanite and (or) kyanite is generally present. Small grains of magnetite are scattered throughout most outcrops and the assemblage garnet-staurolite, so common in the lower thin-bedded member of the formation, is rare. Feldspathic gneiss is abundant in the lower half of the unit and seems to be less abundant in the upper half. Clear, unequivocal graded beds have not been found in this unit, although suggestions of grading between gneiss and schist were noted in several places. Thick beds of hornblende-plagioclase amphibolite, commonly boudinaged, appear to be concentrated in the lower part of the member. Beds of coticule, cummingtonite schist, and two-amphibole gneiss have not been found.

Rusty schist occurs in the thick-bedded member as five distinct tongues that thin and pinch out to the north. In the southern part of the Woronoco quadrangle, three of these tongues thicken and merge only to divide again to the south in the northern part of the Southwick and West Granville quadrangles (pl. 1). Although the Cobble Mountain Formation has been complexly deformed in the Blandford and Woronoco quadrangles, detailed mapping has shown that the rusty schist tongues pinch out northward into the nonrusty-weathering schist and gneiss.

In all five tongues, the rusty schist is a brown to orange-brown-weathering medium- to coarse-grained mica-quartz-plagioclase-garnet schist with slightly rusty to nonrusty, thin (15 cm or less) beds of light-colored carbonate-free calc-silicate gneiss. Garnet is commonly abundant and is locally 4–10 mm in size, forming a bumpy surface parallel to the schistosity. Plagioclase is commonly more abundant than quartz, and muscovite and biotite are commonly equal in amount, although muscovite-rich schists are not uncommon. Beds of amphibolite are rare. Beds of nonrusty-weathering feldspathic schist 30–50 cm thick are intercalated here and there with the rusty schist and gneiss and are particularly abundant near the contact with the nonrusty-weathering feldspathic gneiss and schist.

The uppermost rusty tongue in the thick-bedded member is distinctive in that it contains, in addition to the same type rocks as are in the other rusty tongues, brown-rusty-weathering thinly bedded gneiss and schist, graphitic yellow-weathering schist, thin beds of vitreous quartzite, and rusty-weathering granular schist. The thinly bedded schist and gneiss are not graded but consist of alternating beds of schist and gneiss that range in thickness from 3 to 8 cm; the schist and gneiss are commonly found in the upper 5–15 m of the upper rusty tongue near the contact with the overlying Goshen Formation. The graphitic schist constitutes only a minor fraction of the upper rusty tongue, but where it is found it is commonly associated with sulfidic-weathering schist. The vitreous quartzite is commonly less than 6 cm thick and is found in the upper part of this rusty tongue. The granular schist weathers to a light-rusty color and contains discontinuous laminae of quartz and feldspar that give the rock a distinctive aspect. Although the upper rusty tongue does contain these distinctive rock types, it can be distinguished from the other four rusty tongues only after the complete tongue has been traversed across the strike.

A nonrusty-weathering sillimanite- and (or) kyanite-feldspar-mica-quartz schist occurs locally in a restricted stratigraphic interval as much as 275 m thick near the top of the Cobble Mountain Formation. We have mapped this aluminous schist in the southern part of the Woronoco quadrangle; we have also traced it a few kilometers south into the northern part of the Southwick quadrangle (pl. 1), but the southward limit of this unit is not presently known. Careful mapping of the aluminous schist in the Woronoco quadrangle has shown that it fingers out to the north into the uppermost of the rusty schist units described in the preceding paragraphs.

The aluminous schist commonly contains porphyroblasts of kyanite and plagioclase as much as 2 cm long. Sillimanite, quartz, and plagioclase generally occur in clots that form bumps or warts on weathered surfaces. Although this porphyroblastic aluminous schist looks similar to the noncarbonaceous green schist of the Rowe Schist in the Blandford quadrangle, it is different in that biotite is more abundant, and it does not have the bluish-green cast or the thin (1–2 cm) lenses or laminae of quartz so typical of the aluminous schists in the Rowe. Furthermore, the aluminous schist of the Cobble Mountain Formation fingers out into and is interlayered with rusty-weathering schist, whereas the aluminous schist of the Rowe is interlayered with nonrusty-weathering two-mica schist with large porphyroblasts of garnet and staurolite. Finally, the intertonguing of the Cobble Mountain aluminous schist with rocks that overlie lateral equivalents of the Hawley Formation make a stratigraphic correlation with the Rowe impossible.

In summary, the key features of the thick-bedded or upper member of the Cobble Mountain Formation are the thickness of the beds of feldspathic gneiss, the medium- to coarse-grain size, the abundance of plagioclase in most of the rocks, the assemblage sillimanite- and (or) kyanite-garnet-magnetite in the pelitic rocks, and the rusty schists. These features, together, make this member easily distinguishable from the thin-bedded or lower member of the formation and from the other units in the Blandford quadrangle.

UPPER AND LOWER CONTACTS

The lower contact of the Cobble Formation appears gradational with the Moretown Formation, but it is conveniently marked in much of the Blandford quadrangle by the base of the red-rusty schist in the lower part of the thin-bedded member. Where the red-rusty schist is missing, the base of the formation is placed between outcrops characterized by thick massive pinstriped granulite and granulitic schist typical of the Moretown Formation and outcrops that contain the characteristic light-brown-weathered thin-bedded granulite and schist of the lower member of the Cobble Mountain Formation.

The upper contact of the Cobble Mountain Formation is marked by the first appearance of either the thinly bedded, graded-bedded carbonaceous schist and micaceous quartzite of the Goshen Formation or the calc-silicate granulite and quartzite of the Russell Mountain Formation (Hatch, Stanley, and Clark, 1970). The northward extension of this contact has been described as a "major regional unconformity" (Hatch, 1967, p. D14). Further evidence for this unconformity is found in the Blandford quadrangle where the base of the Goshen rests on successively older units of the Cobble Mountain and Hawley Formations (Hatch and Stanley, unpub. data; this report, pl. 1, fig. 1).

In those places in the Blandford and Woronoco quadrangles where thinly bedded schist and gneiss are present at the top of the uppermost rusty unit of the Cobble Mountain Formation, the upper contact of the formation is more difficult to recognize, particularly where the Russell Mountain Formation is missing. Careful mapping along this contact has shown that the Russell Mountain Formation (commonly less than 7 m thick) occurs in many places between distinctive outcrops of Goshen rocks and Cobble Mountain rocks. The light-rusty-weathering thin-bedded schist and gneiss of the Cobble Mountain Formation can be misidentified as Goshen if the distinction is based solely on bedding characteristics. By the use of most of the criteria listed in table 1, particularly 3–6, these thinly bedded rocks can be distinguished from the basal Goshen rocks. In fact, additional outcrops of the Russell Mountain Formation were located in the Woronoco quadrangle by careful use of these four criteria. Perhaps the most distinctive feature of the basal part of the Goshen is the graphitic sheen on the schistosity surfaces.

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TABLE 1.—*Characteristic features of upper Cobble Mountain rocks and basal Goshen rocks useful in distinguishing the two units.*

Upper part of the Cobble Mountain Formation	*Basal part of the Goshen Formation*
1. Brown- to orange-brown- to red-rusty-weathering feldspathic and micaceous schist with subordinate beds of nonrusty-weathering feldspathic schist. Commonly nongraphitic except in yellow-rusty-weathering sulfidic zones.	Rusty- to red-rusty-weathering carbonaceous schist generally interlayered with thin (1–10 cm) beds of micaceous quartzite. Where bedded, schist beds are 5–30 cm thick.
2. Muscovite-biotite ratio commonly 1 in schists; ratio locally greater or less than 1.	Muscovite-biotite ratio commonly greater than 1 in schists.
3. Muscovite and biotite grains generally same size, producing a coarse "salt and pepper" pattern on some foliation surfaces.	Muscovite grains tend to be larger than biotite.
4. Garnets in schist 5–15 mm in size. Commonly sparse and cloudy. Where garnets large and numerous, schistosity of rock is bumpy.	Garnets in schist 2–4 mm in size. Commonly more abundant and clearer than in Cobble Mountain rocks.
5. Graphite, where present, is clotted or forms dark streaks in carbonaceous schists. Graphite commonly absent.	Graphite forms distinctive sheen on schistosity surfaces. Graphite nearly ubiquitous in schists.
6. Quartz-plagioclase ratio commonly 1 or less.	Quartz-plagioclase ratio greater than 1.
7. Calc-silicate rocks commonly zoned with quartz, feldspar, garnet, diopside, and epidote abundant in light-colored centers and hornblende concentrated in 2–4 mm zones toward outside of each bed. Calcite absent.	Calc-silicate rocks commonly zoned with thin light-colored centers of quartz, feldspar, garnet, diopside, and epidote and thick rims of hornblende. Calcite commonly present. Calc-silicate rocks generally more hornblende-rich than those in Cobble Mountain Formation.
8. Plagioclase-quartz-mica gneiss common.	Plagioclase-quartz-mica gneiss rare.
9. Graded beds very subtle or absent.	Graded beds common and obvious.
10. Thin (2–6 mm) vitreous quartzites that may be dark colored on fresh surfaces.	Thin, dark-colored, vitreous quartzites absent.

THICKNESS

The thickness of the Cobble Mountain Formation can be estimated only very approximately. Immediately southwest of Blandford village (fig. 1) where only the thin-bedded member is present, the formation is only about 600 m thick. About 4 km to the east the thin-bedded member has an estimated thickness of about 1000 m. The thick-bedded member gradually thickens from 0 immediately northeast of Blandford village to approximately 1,000 m around Cobble Mountain Reservoir. Thus the total thickness of the formation in the type area is about 2,000 m.

CORRELATION AND AGE

The Cobble Mountain Formation, as described above (p. 9) is, at least in large part, a facies equivalent of the Hawley Formation. Where the two formations pass laterally into each other by
tain is physically continuous with and is the exact stratigraphic
tain in physically continuous with and is the exact stratigraphic equivalent of the Hawley. The thick-bedded member of the Cobble Mountain, which overlies the thin-bedded member east and south of Blandford, is not present north of Blandford. The lithostratigraphic and chronostratigraphic relations between these two major members of the Cobble Mountain are not precisely known. If the boundary between the two members is a time line, or nearly so, then the upper member is entirely younger than the thin-bedded member and thus is younger than the Hawley Formation— or at least that part of the Hawley presently exposed near Blandford. The pattern of mapped members of the Hawley suggests that progressively older rocks form the present top (uppermost exposed beds) of the Hawley, north along the Hawley-Goshen contact in the southern half of the Chester quadrangle (pl. 1). The persistence of thin units at and near the top of the Hawley north of the Chester quadrangle (Hatch, 1969; Osberg and others, 1971; Hatch and Hartshorn, 1968) indicates that the top of the formation is essentially coeval from Chester village north to the Vermont State line (pl. 1). Thus, if, as the authors tentatively assume here, the boundary between members of the Cobble Mountain is a time surface, then the upper member probably is younger than the Hawley. If, however, the boundary is time-transgressive and the two members are in part or entirely time-correlative, then the entire Cobble Mountain Formation may be time-correlative with the Hawley. Further correlations of the Cobble Mountain are discussed below in the section on correlations with Connecticut.

No fossils have been found in the Cobble Mountain Formation, and the high metamorphic grade of the kyanite and sillimanite zones and the intensity of deformation make future fossil finds very unlikely. The age of the Cobble Mountain is therefore based entirely on the age of the Hawley (Hatch, 1967, p. D12). The

Hawley, itself unfossiliferous, depends for an age assignment upon correlation with parts of the Missisquoi Formation of Vermont (Doll and others, 1961), which in turn derives its age assignment from Middle Ordovician fossils in the Magog Formation on strike at Castle Brook, Magog, Quebec (Boucot and Drapeau, 1968; Cady, 1960). The airline distance from Castle Brook to Blandford, Mass., is about 350 km. In the complexly deformed strata of a eugeosynclinal belt, such a distance casts considerable doubt upon the reliability of an age assignment. Unreliable as it may be, however, our Middle Ordovician age assignment for the Cobble Mountain is the best possible with the present state of knowledge.

RUSSELL MOUNTAIN FORMATION

The Russell Mountain Formation (Hatch, Stanley, and Clark, 1970) consists of calc-silicate granulite, calc-silicate marble, and quartzite. It has been mapped in the Blandford and Woronoco quadrangles but was not recognized to the north in Massachusetts. The formation occupies a position between the Cobble Mountain Formation and the Goshen Formation and has been assigned a Middle Silurian age (Hatch, Stanley, and Clark, 1970, p. B7–B9) largely because it is correlated with the Shaw Mountain Formation of Vermont.

GOSHEN FORMATION

The Goshen Formation (Hatch, 1967) underlies much of the eastern part of the area studied in Massachusetts. It forms a continuous belt from the Vermont State line south to within 1.5 km of the south edge of the Woronoco quadrangle where the Goshen disappears under the Triassic rocks of the Connecticut River valley (pl. 1). In the western part of its outcrop area in Massachusetts, the Goshen is predominantly a thinly bedded, graded bedded unit of carbonaceous pelitic schist and micaceous quartzite. A thicker bedded quartzite and micaceous quartzite unit overlies these rocks and has been mapped separately in all but the northernmost few miles of western Massachusetts; it is not shown separately on plate 1.

WAITS RIVER FORMATION

East of the Goshen Formation in the northernmost part of Massachusetts is a sequence of gray carbonaceous poorly bedded phyllite and schist distinguished from the Goshen by the presence of scattered beds 15 cm to 10 m thick of dark-brown porousweathering carbonate-calc-silicate granulite. This sequence of rocks is continuous with the Waits River Formation of southernmost Vermont (Doll and others, 1961) and is largely but not entirely the Conway Schist of Emerson (1898a, b). The name Waits River Formation has been used for these rocks in northern Massachusetts in the Heath quadrangle (Hatch and Hartshorn, 1968).

Reconnaissance and preliminary detailed mapping in the Ashfield and Goshen quadrangles, Massachusetts (pl. 1), suggests that rocks of the Waits River Formation continue south into these quadrangles. We hope that additional mapping will clarify the structural and stratigraphic relations of these rocks.

SUMMARY OF MASSACHUSETTS SECTION

In summary, the major north-to-south lithologic change in the Paleozoic sequence east of the Precambrian Berkshire massif in Massachusetts takes place between the Hawley Formation and its correlative the Cobble Mountain Formation in the vicinity of the village of Blandford. The marked thinning and textural change of the Moretown Formation are also significant. Rocks equivalent to the Moretown and Hawley Formations (the Middle Ordovician part of the section) south of Blandford form a thick sequence of predominantly silvery-gray or gray-brown fine- to coarse-grained noncarbonaceous nonsulfidic schist, gneiss, and granulite. Scattered thin beds or sills of amphibolite, generally no more than a few meters thick, are present in the Cobble Mountain Formation, but black schist and the conspicuous thick units of metavolcanic rock that characterize the Middle Ordovician section in the northern part of Massachusetts, eastern Vermont (Doll and others, 1961), and western New Hampshire (Billings, 1956) are apparently absent in Massachusetts south of Blandford.

DISCUSSION OF STRATIGRAPHIC SECTIONS

The foregoing pages have summarized the results of many seasons of continuous detailed tracing of stratigraphic units across western Massachusetts. Stratigraphic sections 1, 2, and 3 at the end of this report are prepared from published and unpublished maps by the authors and their colleagues of the area studied in Massachusetts. They summarize the stratigraphy across Massachusetts. Stratigraphic sections 4–11 are from southernmost Massachusetts and west-central Connecticut; the descriptions and the sequences and thicknesses of lithostratigraphic units are taken from available published geologic maps.

In our reconnaissance studies of southernmost Massachusetts and western Connecticut we have noted what appear to us to be stratigraphic inconsistencies. Many geologists have been involved in mapping these areas, including principally, in approximate north-to-south order, R. W. Schnabel, H. E. Simpson, R. M. Cassie, R. M. Gates, C. W. Martin, M. H. Carr, C. E. Fritts, R. W. Scott, W. P. Crowley, J. H. Dieterich, and H. R. Burger. Because of the number of geologists involved, the approximately 20 years' time during which the mapping was done, the complexity of the geology, and the inevitable evolution of geologic ideas in such an area, differences in usage of certain formational names are to be expected. Many thousands of meters of schist and gneiss underlie western Connecticut, and they have been subdivided in many ways, depending upon the physical properties used as the basis for subdivision. Furthermore, the stratigraphic sequences proposed by these workers are based on a variety of commonly conflicting structural hypotheses. The lack of fossils and the scarcity of sedimentary structural features such as graded bedding means that correlation between local sections and the better documented sections of northern Massachusetts and southeastern Vermont must be based on careful lithologic comparisons and stratigraphic sequences. By looking at a large number of exposures throughout the area of plate 1 in a relatively short time, we hope to achieve coherence and standardization that perhaps were not possible when many geologists each looked more closely at a smaller area.

The emphasis in the stratigraphic sections is on lithologic descriptions rather than on stratigraphic nomenclature because we believe that many formation and member names have been used differently in different areas by different geologists. Thus, many named units include rocks that we would assign to totally different parts of our stratigraphic section.

The purpose of this part of the report is to analyze the stratigraphic sections and the maps from which they are taken and to ascertain if, within the constraints of available structural and sedimentary tops data, any reasonable correlations can be proposed between the stratified rocks of west-central Massachusets and the many sections proposed for the stratified rocks of western Connecticut. For some areas, particularly the Collinsville, Conn. area, we propose a correlation of the entire section; for other areas, because of an admittedly incomplete understanding of some of the stratigraphic and structural relations, we are less confident in some of our correlations. All the rocks in each section should, and indeed must eventually, correlate with or have a definite stratigraphic relation to some part of the rocks in the sections to the north. We do not propose to have all the answers or to have solved all the problems, but we feel that most of the correlations proposed are soundly based and are not invalidated by our uncertainties about some other units. We hope that students of the geology of southwestern New England will, by more detailed restudy of pertinent areas and by application of new data from geophysical and other sources, refine and modify the general proposals presented here.

The proposal we wish to emphasize in this report is the correlation of the rocks at the top of the sections in Massachusetts with lithologically similar rocks in Connecticut and southernmost Massachusetts. This correlation requires revision not only in the geologic age of many of the rocks south of the Blandford and Woronoco quadrangles, but also requires changes in conceptions of their stratigraphic sequence and their structural position.

In the following discussion of individual quadrangles and groups of quadrangles, we go into considerable detail to clarify and fully substantiate our reasons for the correlations that we propose (shown on pl. 2). Although we have tried to base these discussions on geographic localities identifiable on plate 1, the reader interested in the particulars may want to refer to some of the original quadrangle maps. Finally, the reader not so interested in the supporting details can, with the aid of plates 1 and 2, turn directly to the section on summary discussion of correlations.

WEST GRANVILLE, SOUTHWICK, NEW HARTFORD, AND TARIFFVILLE QUADRANGLES

The area of Paleozoic rocks between the Blandford quadrangle and the Collinsville quadrangle (pl. 1) is being studied by R. W. Schnabel (Schnabel and Eric, 1965; Hatch and others, 1968; Schnabel, 1971). The north end of the Granville dome (pl. 1) has also been studied in detail by Stanley (1967), and we have done reconnaissance mapping partly in company with Schnabel in most of the rest of the West Granville, Southwick, and New Hartford quadrangles. The stratigraphic section for this area proposed by Schnabel (in Hatch and others, 1968) is presented here as stratigraphic section 4.

The sequence of units in stratigraphic section 4 is not obviously correlative with sections 1 and 2 north of Blandford, Mass., a fact that Schnabel and the present authors have long recognized. Since publication of an earlier report (Hatch and others, 1968), mapping has been completed in the Chester (Hatch, Norton, and Clark, 1970), Blandford (Hatch and Stanley, unpub. data), and Woronoco quadrangles (S. F. Clark, Jr., Stanley, and Hatch, unpub. data), (pl. 1). We have examined or reexamined many of the exposures of the rocks of Unit 5 of section 4 to compare these rocks with those to the north and to determine the facing direction and the reliability of the graded beds upon which the sequence of the units in this section depends. Unit 5 is exposed in the area west of Southwick that is shown as Silurian and Devonian rocks on plate 1. Although the sense of tops in most key exposures is ambiguous, some exposures of both east- and west-facing beds were found in Unit 5 west of the Granville dome, and no exposures of unambiguous tops were found closer than a few hundred feet from the west contact of this belt. From this we have concluded: (1) that isoclinal folds must be present in this unit because bedding attitudes do not change between adjacent exposures of east- and west-facing beds, and (2) that lithic correlation of distinctive units is more useful than ambiguous tops data in determining the stratigraphic sequence of these units.

Most of the rocks of Unit 5 of section 4 bear a striking resemblance to the rocks of the lower part of the Goshen Formation in southern Massachusetts. Both Unit 5 and the lower part of the Goshen consist of thinly bedded, commonly graded-bedded carbonaceous micaceous schist and quartzose schist, with minor beds of calc-silicate granulite. Both are characterized by abundant isoclinal folds (Hatch, 1968b). The graphitic sheen on schistosity surfaces of fine-grained muscovite, which characterizes the Goshen schists to the north, is also present in the schists of Unit 5. The 1–2 cm thick beds that characterize much of the Goshen Formation in southern Massachusetts are also conspicuous in much of Unit 5. Furthermore, both the Goshen and most of Unit 5 are devoid of coticule rock and the hornblende-plagioclase amphibolite and feldspar gneiss and schist that are common in all the pre-Silurian units in Massachusetts. The base of Unit 5, however, below an apparently sharp stratigraphic boundary, is more feldspathic and contains abundant coticule rocks.

On this basis, all but the coticule-bearing basal part of Unit 5 is correlated with the lower thinly bedded part of the Goshen Formation in Massachusetts. Inasmuch as all the other units, except Unit 6, in section 4, are lithically similar to the pre-Silurian rocks to the north, Unit 5 must be at the top of the column if the proposed correlation is correct. A major consequence of this correlation is that Unit 5 must lie in a syncline around the Granville and Granby domes (pl. 1), and the rocks in the cores of the domes are, in part, stratigraphically equivalent to the rocks outside the domes.

Bordering Unit 5 on the north and west in the Southwick quadrangle (pl. 1) is a thin unit of calc-silicate rock, amphibolite, quartzite, and schist (Unit 6 of section 4). These are the same rocks that make up the thin, discontinuous but distinctive Russell Mountain Formation in Massachusetts to the north. On the basis of this lithologic similarity and the stratigraphic position of Unit 6 between Goshen-like rocks and apparent pre-Silurian rocks, that part of Unit 6 north of the Granville dome in the Southwick quadrangle (pl. 1) would correlate with the Russell Mountain Formation. The very southern part of Unit 6 on figure 13–1 of Hatch, Schnabel, and Norton (1968) (labeled Ohb on pl. 1, this report, in the southern part of the New Hartford quadrangle) consists of carbonaceous schist and quartzite that are traceable into part of the Rattlesnake Hill Formation in the Collinsville quadrangle, which we correlate with the Hawley Formation to the north.

If the correlation of Unit 5 with the Goshen Formation and the proposed synclinal structure consequent upon that correlation are correct, Unit 6 should theoretically occur between Units 5 and 4 inside the domes. Calc-silicate rock, amphibolite, or quartzite are not known at this position. The Russell Mountain Formation in southern Massachusetts (Hatch, Stanley, and Clark, 1970) and the correlative Shaw Mountain Formation in Vermont (Doll and others, 1961) are discontinuous units. The absence of Unit 6 around the Granby and Granville domes, therefore, is not necessarily a meaningful argument against correlation of Unit 6 with the Russell Mountain Formation, although it does detract from the stratigraphic symmetry of the proposed syncline.

All the remaining units of section 4 are considered to be pre-Silurian. Subdivision of the rocks making up these units is open to several interpretations, one of which is shown here on plate 1.

According to the synclinal structure proposed above (p. 20), Unit 7 and possibly more or less of Unit 8 are stratigraphically below Units 6 and 5 and are stratigraphically, if not lithically, correlative with Unit 4 (see fig. 13–1 of Hatch and others, 1968).

Unit 4 in the core of the Granby and Granville domes is very poorly exposed but appears to consist of amphibolite and felsic gneiss of probable igneous origin. Feldspathic mica gneiss and schist are also present. These rocks are similar to many of the rocks in the Collinsville and Bristol domes in Connecticut (Stanley, 1964, 1967). Similar rocks are also present in the Shelburne Falls dome (Balk, 1946; Segerstrom, 1956b; Hatch and Hartshorn, 1968) and the Goshen dome (Emerson, 1898a, b; Hatch, unpub. data) to the north where they are considered a facies of the Hawley Formation (Hatch and Hartshorn, 1968; Stanley, 1967).

Unit 7 in the West Granville and Southwick quadrangles contains schist and gneiss lithically identical to the rocks that make up most of the thick-bedded member of the Cobble Mountain Formation described on page 10, and we propose the correlation of these two units. In a previous section of this report (p. 15), we correlated the Cobble Mountain with the Hawley Formation on the basis of a mapped facies change just north of Blandford (pl. 1). The correlation of Unit 7 with Unit 4 emphasizes another facies change that appears to be repeated along virtually all the domes of southwestern New England from the Shelburne Falls dome south to the Waterbury dome. Schnabel's Unit 4 and the rocks that we equate with it in the domes to the south contain more felsic gneiss and amphibolite, whereas Unit 7 and the Cobble Mountain Formation and correlative rocks west of the domes to the south contain more aluminous schist and carbonaceous schist as well as the feldspathic schist and gneiss. This proposed east-west facies change can be viewed as a change from a volcanic environment on the east to a dominantly clastic environment on the west during much of Middle Ordovician time.

Unit 7 in the southern part of the New Hartford quadrangle is lithically different from Unit 7 in the West Granville quadrangle. In the southern part of the New Hartford quadrangle, Unit 7 includes carbonaceous schist and quartzite (upper member of the Rattlesnake Hill Formation); gray micaceous granulite, light-colored schist, garnet-staurolite schist, and minor calc-silicate gneiss and amphibolite (Satans Kingdom Formation); and kyanite-rich schist, garnet-staurolite schist, rusty schist, and amphibolite (Slashers Ledges Formation) (all of Stanley, 1964). These rocks in the Collinsville quadrangle are lithically correlative with those in the stratigraphic interval from the Rowe Schist to the Moretown and part of the Hawley Formation of western Massachusetts. In the West Granville quadrangle, Unit 7 is continuous with the Cobble Mountain Formation which we interpret as a facies equivalent of the Hawley Formation; therefore, according to our correlation scheme, Unit 7 represents two quite different intervals of the western Massachusetts section. Unit 7 appears to change 3–5 km north of the south edge of the New Hartford quadrangle. The geologic nature of this change is presently unknown.

Unit 8 (Hatch and others, 1968, p. 183), which is west of Unit 7, is difficult to recognize and categorize in terms of the section to the north or south. On the basis of the Massachusetts section, the presence of coticule rocks strongly suggests a pre-Silurian, and most probably a Middle Ordovician, age for this unit. The graded beds reported by Schnabel (Hatch and others, 1968, p. 183) in Unit 8 suggest that it includes the thin-bedded member of the Cobble Mountain Formation, although this correlation is incompatible with the superposition of Unit 8 over Unit 7 shown in section 4. In the central part of the New Hartford quadrangle, Unit 8 contains rocks that are lithically similar to the upper member of the Rattlesnake Hill Formation and the Satans Kingdom Formation (Stanley, 1964) and, hence, would be approxi mately equivalent to the Moretown-lower Hawley interval.

Continuing westward, the pinstripe character of Unit 3 strongly suggests the correlation with the Moretown Formation to the north already proposed (Hatch and others, 1968, fig. 13–2).

The upper green schist and the lower gray schist members of the Rowe Schist (section 3) can be traced for 6 km south into the West Granville quadrangle. They are also present in the southern part of the New Hartford quadrangle, as shown on plate 1. In the West Granville quadrangle, these rocks appear to be mapped either as Unit 1 or as Unit 2, but in the New Hartford quadrangle, they appear to be mapped as the western part of Unit 7.

Finally, we agree with the earlier correlation (Hatch and others, 1968, fig. 13–1) of Unit 1 with the Hoosac Formation of Massachusetts.

COLLINSVILLE QUADRANGLE

Immediately south of the area mapped by Schnabel is the Collinsville quadrangle (pl. 1). The sequence and description of the stratified rocks of this area, presented here as stratigraphic section 5, are taken from Stanley's quadrangle report (Stanley, 1964). The sequences for the domes and for the major northeast-trending folds in the northwest part of the quadrangle are based on the positions of units within these major structures, but the relative age of these sequences is in no way fixed. Because the rocks are not fossiliferous and are generally devoid of reliable primary tops information, the 1964 sequence was based on the assumptions that the oldest rocks were in the core of the Bristol dome and that the sequence in the northeast-trending folds was inverted (Stanley, 1964, p. 10–15). The assumption for the domes has proved correct in eastern Vermont and western New Hampshire, and there is no reason as yet to doubt its validity in western Connecticut. Although the assumption for the northeast-trending folds was speculative, it was based on the dissimilarities between the sequence in the domes and the sequence in the major folds.

Subsequent work by the authors in western Massachusetts indicates, however, that the sequence in the northeast-trending folds is right-side-up and in part equivalent to the sequence below the

Straits Schist in the domes. The youngest formation in the quadrangle now appears to be The Straits Schist and the oldest the Slashers Ledges Formation.

The revised stratigraphic scheme for the Collinsville area was first presented in 1968 (Stanley, 1968, p. 6), and subsequent studies in western Massachusetts and Connecticut have resulted in some further modification (Hatch and Stanley, 1970).

The rocks mapped as The Straits Schist in the Collinsville quadrangle are strikingly similar to the rocks of the lower part of the Goshen Formation in southern Massachusetts and to the rocks of Unit 5 of section 4. They are thinly bedded, locally graded-bedded rusty-weathering carbonaceous pelitic schist. Although recognizable graded beds are present, most are less distinctly graded than the graded beds in the Goshen Formation in Massachusetts. Conspicuously graded beds in the Collinsville quadrangle 100 m east of the Russell Mountain Formation (100 m east of the contact of The Straits with the lower member of the Rattlesnake Hill Formation along Bahre Johnson Road between Canton Center and Rattlesnake Hill on pl. 1 of Stanley, 1964), indicate that The Straits is younger than the Russell Mountain and Rattlesnake Hill (Cobble Mountain on pl. 1). The easternmost 30–50 m of the Rattlesnake Hill on pl. 1 of Stanley, 1964), indicate that The area consists of calc-silicate gneiss and quartzite which are now correlated with the Russell Mountain Formation of western Massachusetts. Although we have carefully searched for diagnostic graded beds closer to both the eastern and western contacts of The Straits in order to further corroborate age relationships, no such evidence was found. A comparison of the sequence of rocks near Bahre Johnson Road with the sequence in the Blandford and Woronoco quadrangles in Massachusetts further suggests that the Bahre Johnson Road rocks become progressively older to the northwest from the outcrop of graded beds. Thus, the graded beds in the Collinsville quadrangle agree with the relative age sequence deduced from our correlation.

The outcrops just east of Bahre Johnson Road are one of four localities along the western contact of The Straits Schist where Stanley (1964, pl. 1) mapped exposures of "quartzite" and "calc-silicate gneiss or granulite" in the lower member of the Rattlesnake Hill Formation. These rocks have not been found between The Straits Schist and the Sweetheart Mountain Member of the Collinsville Formation. They are lithically identical with and, we believe, at the same stratigraphic horizon as the Russel Mountain Formation in the Blandford and Woronoco area and with Unit 6 in the Southwick and New Hartford quadrangles.

As a consequence of reinterpreting the sequence of the rocks in the northwestern part of the Collingsville quadrangle, the upper member of the Rattlesnake Hill Formation of Stanley (1964) is now believed to be the stratigraphically "lower" member, and the lower member the stratigraphically "higher." To avoid further confusion, the two members will, for the remainder of this report, be referred to as follows:

Old name	*New name*
Lower member	Feldspathic schist member
Upper member	Carbonaceous schist member

Both the feldspathic schist member of the Rattlesnake Hill and the Sweetheart Mountain Member of the Collinsville Formation consist of feldspathic mica-kyanite-garnet schist lithically similar to the nonrusty feldspathic schist of the thick-bedded member of the Cobble Mountain Formation in the Blandford and Woronoco quadrangles. We correlate these three units. Some of the feldspathic two-mica gneiss and schist in the Bristol Member of the Collinsville Formation may also be equivalent to the thick-bedded member of the Cobble Mountain.

The carbonaceous schist member of the Rattlesnake Hill Formation is in large part rusty-weathering carbonaceous schist and thin quartzite (Stanley, 1964, p. 33–36). We correlate this unit with the strikingly similar carbonaceous schist of the Hawley Formation. The presence in the Collinsville area of feldspathic schist overlying carbonaceous schist indicates that the thin-bedded member of the Cobble Mountain Formation is, in a grossly simplified way, a large lithically distinct lens within the carbonaceous schist and quartzite of the Hawley and Rattlesnake Hill Formations. This relation is schematically shown in figure 2.

Thick units of mafic metavolcanic rocks analogous to those in the Hawley Formation in the northern part of Massachusetts (for example, Osberg and others, 1971; see also stratigraphic section 1, this report) have not as yet been recognized in west-central Connecticut, although thin beds and lenses of amphibolite are present. The feldspathic mica schist and gneiss in the Collinsville Formation and the feldspathic schist member of the Rattlesnake Hill Formation probably contain a high percentage of felsic volcanic detritus. The plagioclase gneiss in the Bristol Member of the Collinsville Formation is probably metamorphosed felsic volcanic material and, therefore, is similar to the layered plagioclase gneiss mapped by Hatch in the Shelburne Falls dome and in the main belt of Hawley to the west in the Heath quadrangle (Hatch and Hartshorn, 1968) (pl. 1). In the Heath quadrangle, the Hawley

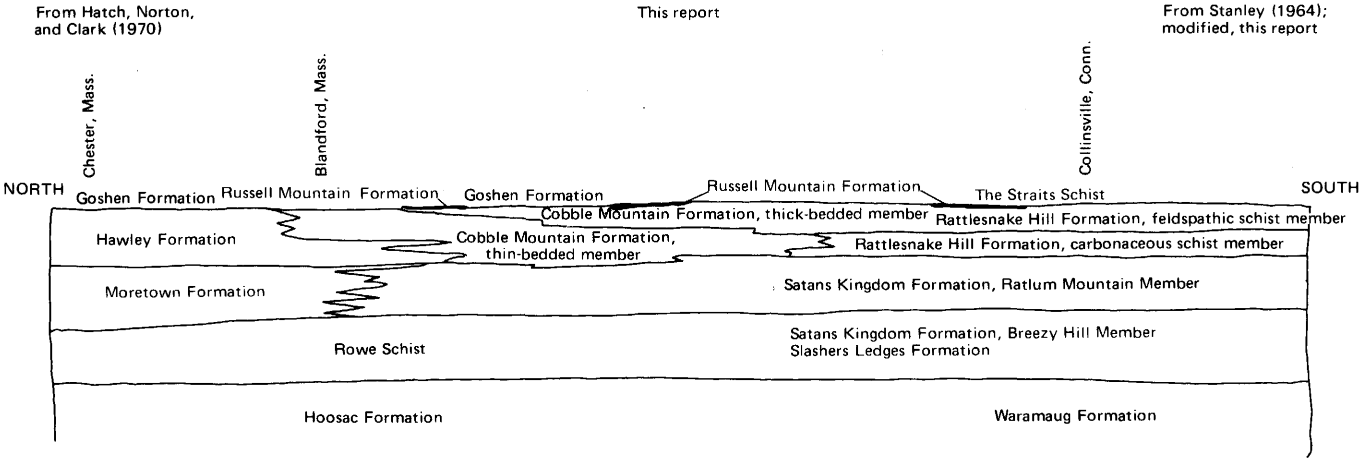

FIGURE 2.—Schematic restored longitudinal section between **Chester, Mass., and the Collinsville, Conn., area showing possible original facies relations between the rocks of the Cobble Mountain Formation and correlative rocks to the north and south. See text for discussion.**

contains abundant metavolcanic rock in both the dome and the main belt west of the Goshen Formation (pl. 1). In the Collinsville quadrangle, metavolcanic material is abundant in the domes (Collinsville Formation) and is represented west of the domes by the stratigraphically equivalent feldspathic schist member of the Rattlesnake Hill Formation. In both the Heath and Collinsville areas, the carbonaceous black schists are absent in the domes and are conspicuous in the belt to the west. Thus, as the stratigraphic interval of the Hawley west of the domes is traced southward, it appears that (1) it becomes less volcanic, (2) the ratio of mafic to felsic volcanic material decreases, (3) the carbonaceous schist not only changes facies to noncarbonaceous schist and granulite (thin-bedded member of the Cobble Mountain Formation) but is overlain by feldspathic mica schist and gneiss (thick-bedded member of the Cobble Mountain Formation, the feldspathic schist member of the Rattlesnake Hill Formation, and the Sweetheart Mountain Member of the Collinsville Formation), which are present both within and west of the Collinsville and Bristol domes.

The Ratlum Mountain Member of the Satans Kingdom Formation and the Taine Mountain Formation in the Collinsville quadrangle are the two units that most resemble the Moretown Formation of western Massachusetts and eastern Vermont. The Ratlum Mountain Member is confined to the area of major folds west of the domes and contains beds of light-gray granulite and gneiss that are lithically identical to the pinstriped granulite in the Moretown Formation north of the village of Blandford, Mass. South of Blandford, the Moretown becomes more schistose and contains many beds of rock characteristic of the Ratlum Mountain Member in the Collinsville quadrangle. Based on these lithic similarities and its stratigraphic position below the carbonaceous rocks typical of the Hawley and above the aluminous rocks typical of the Rowe, we correlate the Ratlum Mountain Member of the Satans Kingdom Formation with part of the Moretown Formation of western Massachusetts.

Although the Taine Mountain Formation is restricted to the Bristol dome in the Collinsville quadrangle, farther west it forms a distinct belt around the south end of the Berkshire massif in the West Torrington (Gates and Christensen, 1965), Torrington (Martin, 1970), and New Hartford (Unit 3, in Hatch and others, 1968, p. 178) quadrangles. This belt has been designated Hartland Unit I according to a stratigraphic scheme proposed by Gates (1959) in the Roxbury quadrangle, Connecticut (pl. 1). Similar rocks are found in the Waterbury dome (Gates and Martin, 1967) and in other parts of west-central Connecticut (see Martin, 1970, fig. 9). Despite the differences in nomenclature, these rocks are all fine-grained gray quartz-plagioclase-mica granulite and gneiss in which the micas are concentrated in very thin pinstriped layers. Nonrusty-weathering quartz-mica schist is present but subordinate to the granulite and gneiss. Rusty-weathering schist and subordinate gneiss have been mapped as the Scranton Mountain Member within the Taine Mountain Formation in the Bristol dome. We correlate the Taine Mountain Formation and Hartland Unit I with the Moretown of Massachusetts because the two formations are strikingly similar lithically and because their stratigraphic positions are apparently the same.

By correlating both the Ratlum Mountain Member of the Satans Kingdom Formation and the Taine Mountain Formation with the Moretown, we infer that these two units in the Collinsville quadrangle are facies equivalent to each other, although Stanley (1964) was more impressed with their differences than with their similarities. Both the Ratlum Mountain Member and the Taine Mountain Formation have quartz-plagioclase-mica granulite and gneiss. Those in the Taine Mountain, however, are darker gray and generally have a lower muscovite:biotite ratio than the granulite and gneiss in the Ratlum Mountain Member. Furthermore, the Taine Mountain Formation contains less schist than the Ratlum Mountain Member in which the schist is buff to light-silvery gray with conspicuous porphyroblasts of biotite that are commonly oriented across the foliation. Garnet-staurolite-(kyanite) $\pm$ (sillimanite) is a common assemblage in the schist of the Ratlum Mountain Member, whereas garnet$\pm$kyanite is present in only some of the schist of the Taine Mountain Formation. These differences represent an east-west facies change in which the more schistose equivalent of the Moretown (Ratlum Mountain Member) is bordered on the east and west by the more granulitic equivalent of the Moretown (Taine Mountain Formation). The relation is schematically shown in figure 3.

The proposed east-west changes of facies may shed light on stratigraphic problems in the Hartland Formation farther south in the central part of western Connecticut. In the Torrington quadrangle to the west, Martin (1970, pl. 1) groups the Ratlum Mountain Member of the Satans Kingdom Formation and the carbonaceous schist member of the Rattlesnake Hill Formation into Hartland Unit III. According to the regional map of Martin (1970, fig. 9), Hartland Unit III is separated from Hartland Unit I to the southwest by a thin sliver of Hartland Unit II which

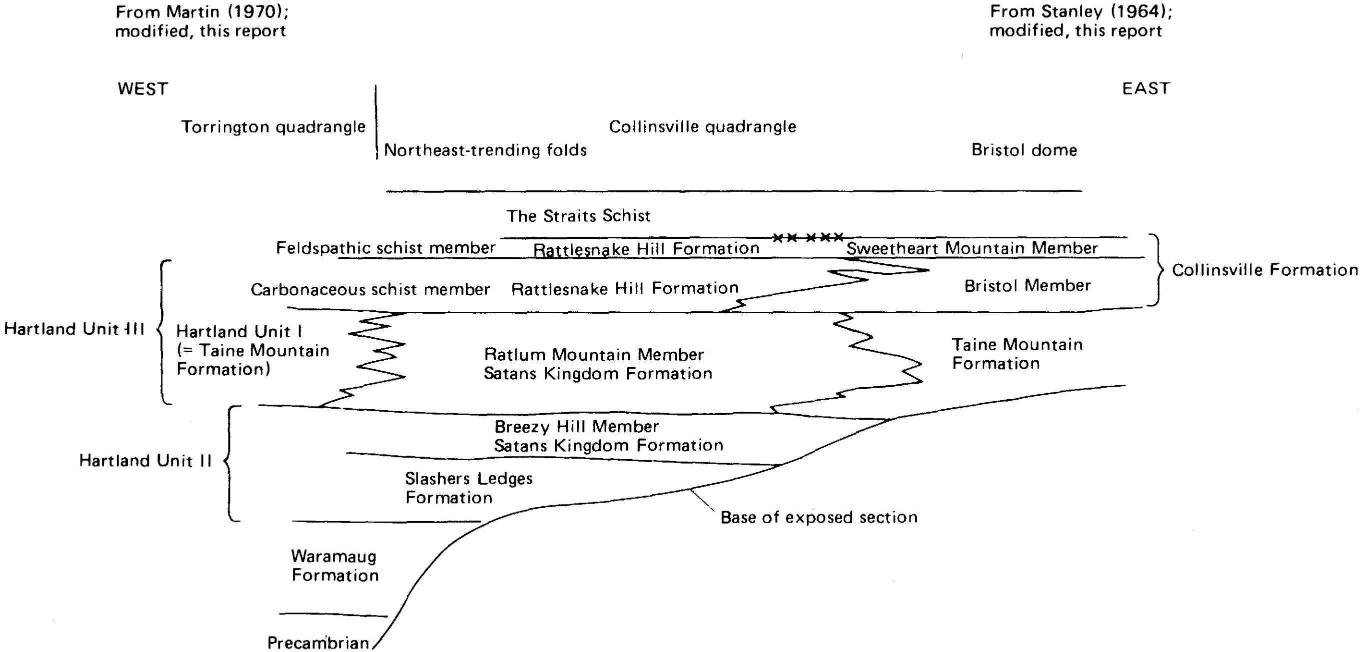

FIGURE 3.—Diagrammatic palinspastic restoration of the east-west facies changes between the domes and the northeast-trending folds in the latitude of the Collinsville quandrangle. XXXXX-unnamed calc-silicate and quartzite unit.

trends southeastward into The Straits Schist in the Thomaston quadrangle (along the Naugatuck River north of Thomaston) (Cassie, 1965). Although we discuss this belt in greater detail below in the section on the Thomaston quadrangle, we believe that Hartland Unit III continues southward and becomes Hartland Unit I (Martin, 1962) and that the southeastward-trending sliver of Hartland Unit II-The Straits consists of rocks more properly mapped as Hartland Unit III or Hartland Unit I. Consequently, we believe that Hartland Units I and III (as used by Martin, 1970) are largely facies equivalents of each other and are both approximately stratigraphically equivalent to the Moretown Formation of western Massachusetts. Inspection of Martin's figure 9 (1970) shows that much of western Connecticut east of the Waramaug Formation is underlain by these units. If they are indeed facies of each other, then separating the two where they intertongue would be difficult and may be the reason for some of the past stratigraphic debates.

The remaining three units in the Collinsville quadrangle are the Breezy Hill Member of the Satans Kingdom Formation and the two members of the Slashers Ledges Formation. These units have been traced from the Collinsville quadrangle northward into the southern part of the New Hartford quadrangle where they apparently disappear, possibly along a thrust fault, only to reappear 16 km to the north in the center of the West Granville quadrangle (pl. 1). From there we have traced them into the Rowe Schist in Massachusetts. The garnet-staurolite schist of the Breezy Hill Member of the Satans Kingdom Formation and the kyanite schist of the Slashers Ledges Formation with its distinctive mineralogy, thin quartz lenses and bluish-gray color are similar to the rocks of the green schist member of the Rowe in the Blandford quadrangle, Massachusetts. The rocks of the rusty schist member of the Slashers Ledges are very similar to the rusty-weathering carbonaceous schist of the gray schist units of the Rowe in Massachusets. We therefore correlate the Slashers Ledges and most of the lower part of the Breezy Hill Member of the Satans Kingdom Formation with the Rowe Schist.

In summary, the stratigraphic correlation between western Massachusetts and the Collinsville quadrangle is based on similar stratigraphic sequences of similar lithologic units. The strongest correlations are between (1) the Rowe Schist and the Slashers Ledges Formation-Breezy Hill Member of the Satans Kingdom Formation, (2) the Moretown Formation and the Taine Mountain Formation, (3) the black schist of the Hawley Formation and the carbonaceous schist of the Rattlesnake Hill Formation,

(4) the calc-silicate gneiss and quartzite of the Rattlesnake Hill Formation and the Russell Mountain Formation, and (5) the Goshen Formation and The Straits Schist. The correlation of the Ratlum Mountain Member of the Satans Kingdom Formation with the Moretown is less reliable because the Moretown becomes more schistose in the southern part of the Blandford quadrangle (pl. 1).

The east-west facies changes in the Collinsville quadrangle that result from this correlation are shown in figure 3. The major changes between the domes and the northeast-trending folds are in (1) the Hawley interval where the volcanic rocks (Bristol Member of the Collinsville Formation) pinch out to the west and the carbonaceous rusty schist (carbonaceous schist member of the Rattlesnake Hill Formation) pinches out to the east, and (2) the Moretown interval where the Taine Mountain becomes more schistose (Ratlum Mountain Member) to the west and then changes back to the typical Taine Mountain lithology and is mapped as Hartland Unit I in the Torrington quadrangle (Martin, 1970).

As a result of reinterpreting The Straits Schist as the youngest formation in the Collinsville quadrangle, Stanley (1968, p. 8) interpreted the belt of The Straits around the domes as an isoclinal syncline that was later refolded by the emplacement of the domes. We now extend this interpretation to the other domes in western Connecticut, consistent with Dieterich's (1968a, b) interpretation of The Straits in the southeastern part of western Connecticut.

TORRINGTON QUADRANGLE

The stratigraphic sequence proposed by Martin (1970) for the Torrington quadrangle (pl. 1) is based on the sequence proposed by Gates (1959) in the Roxbury quadrangle. Martin (1962) extended this sequence northward to the Torrington area. Unit I is considered to be the oldest of the Hartland units "because (1) it is located in the center of foliation domes and anticlines within the Hartland Formation; (2) it is the unit of the Hartland Formation most nearly adjacent to a series of gneiss domes along the eastern edge of the Hartland belt; and (3) it dips consistently to the west or northwest." (Martin, 1970, p. 26; also summarized in Gates and Martin, 1967, p. 24, 25). Hartland Units II, III, and IV form mappable belts west of Unit I. Thus, the central part of western Connecticut southwest of Torrington is interpreted as a broadly folded homoclinal sequence which becomes younger to the northwest (see Martin, 1970, fig. 9). In the West Torrington

(Gates and Christensen, 1965) and Torrington quadrangles, the presence of Unit I just east of the Waramaug Formation, which borders the Berkshire Highlands, requires a structural repetition of part of this four-unit sequence. Because Unit I is also found in the cores of the Bristol and Waterbury domes, the assumption that it is the oldest of the four Hartland units appears to be correct if the stratigraphic sequence in these domes is similar to the eastern Vermont sequence. Martin (1970, p. 27) further concludes that the Collinsville and the Hitchcock Lake Member of the Hartland Formation in the Waterbury quadrangle (Gates and Martin, 1967) pinch out to the west, which is reasonable because they represent volcanic rocks and volcanic detritus. We agree with this particular conclusion.

Martin (1970, p. 38) correlates Unit II with The Straits Schist on the grounds that they both occupy the same position over Unit I. Martin (1970, p. 39) cites as further evidence for this correlation the work of Cassie (1965), discussed in the next section, in the Thomaston quadrangle "where a band of schist can apparently be traced continuously from The Straits Schist near the town of Thomaston to the Unit II belt in the extreme northwestern corner of the Thomaston and southwestern corner of the Torrington quadrangle" (Martin, 1970, p. 39, fig. 9; see also pl. 1, this report). The apparent presence of this southeasterly trending belt is very important because, if it does exist, it verifies Martin's correlation. A consequence of correlating Unit II with The Straits Schist is that Hartland Unit III then forms the trough of a syncline and has, therefore, been placed at the top of section 6.

Martin's conclusions differ substantially from ours. We do not agree on the correlation of Hartland II with The Straits Schist, inasmuch as the two units are totally different lithically and in stratigraphic position. The eastern part of The Straits Schist in the extreme southeastern corner of the Torrington quadrangle (Martin, 1970, pl. 1) is continuous with The Straits Schist in the Collinsville quadrangle, and thus is correlative with the Goshen of western Massachusetts. Hartland Unit II is a southwestern continuation of the Slashers Ledges Formation and the Breezy Hill Member of the Satans Kingdom Formation in the Collinsville quadrangle and thus is correlative with the Rowe Schist of western Massachusetts.

The carbonaceous schist member of the Rattlesnake Hill Formation of the Collinsville area is not mapped as a separate unit by Martin, except perhaps in Unit I of the Hartland where he maps kyanite-staurolite-muscovite-rich granulitic gneiss with a "nubby surface" (1970, p. 28). The carbonaceous schist member of the Rattlesnake Hill Formation in the northwestern part of the Collinsville quadrangle (Stanley, 1964, pl. 1) includes this rock type. Other belts of "fine-grained dark gray or purple-gray granulite and schist with abundant graphite" (Martin, 1970, p. 35) are mapped in Unit III of the Hartland. These rocks are lithically similar to the carbonaceous schist of the Rattlesnake Hill. The remaining part of Unit III is "medium-grained, poorly foliated, silvery schist with randomly oriented, black biotite porphyroblasts and coarse kyanite blades" (Martin, 1970, p. 35). Granulite and kyanite-free mica schist are subordinate rocks. These rock types are typical of the Ratlum Mountain Member of the Satans Kingdom Formation. In the Torrington quadrangle these rocks are interlayered on all scales and, therefore, cannot be mapped separately as they are in the Collinsville quadrangle. Hartland Unit III trends southwesterly into the Thomaston quadrangle where it terminates against the southeasterly trending belt of Hartland Unit II-The Straits (see also fig. 9 of Martin, 1970).

The boundary between the Waramaug Formation and Hartland Unit I presents somewhat of a problem in our scheme of correlation. Our reconnaissance along this boundary indicates that the rocks mapped as Waramaug are lithically similar to the Hoosac Formation of western Massachusetts. The Waramaug can be traced northward through the New Hartford and West Granville quadrangles into the Hoosac Formation of the Blandford quadrangle (pl. 1). If Hartland Unit I is correlated with the Moretown Formation, then the stratigraphic interval represented by the Rowe to the north is either absent or very thin in the Torrington quadrangle. If the Rowe (Hartland Unit II) stratigraphically pinches out from the east side of Hartland Unit I to the west side, then the pinchout is abrupt because the Rowe equivalents are 600–750 m thick in the Collinsville quadrangle and 1,600–1,900 m thick in the Torrington quadrangle immediately east of the belt of Hartland Unit I. Alternatively, the contact between the Waramaug and Hartland Unit I may be a fault. Although we have seen only a few outcrops along this contact, none of them appears sheared or shows any outward evidence of faulting. We suggest that if a fault is present, the movement took place before the major (probably Acadian) recrystallization in the area. Small faults have been mapped in the northwestern part of the Collinsville quadrangle (Stanley, 1964, pl. 1) where they explain the absence of key stratigraphic units west of the major anticline cored by the Slashers Ledges Formation (Stanley, 1968, p. 8). These faults and the tentative one between the Waramaug and Hartland I on plate 1 may be the northern extension of Cameron's Line. Although solution of this problem must await future work, these faults are tentatively shown on plate 1.

THOMASTON QUADRANGLE

The Thomaston quadrangle south of the Torrington quadrangle has been mapped by Cassie (1965). Cassie distinguished schist to which he assigned the name Straits Schist from a large unit of "undifferentiated granulite and schist" and from Reynolds Bridge Gneiss.

The Straits Schist in the northeast part of the Thomaston quadrangle is a southwestern continuation of the belt of The Straits mapped by Stanley (1964) in the southwest part of the Collinsville quadrangle. Cassie (1965) maps this belt of Straits around the southern part of the Bristol dome to the southeastern part of the Thomaston quadrangle where it is continuous with the belt of Goshen-like and Straits-like rocks in the southwestern part of the Bristol quadrangle.

Cassie (1965) also mapped a belt of Straits Schist 1.5 km wide north from the town of Thomaston (roughly along Fenn and Hill Roads, see Thomaston 7½-minute quadrangle) to the north edge of the Thomaston quadrangle (pl. 1). We carefully examined the road exposures along this belt and found a variety of metasedimentary rocks, none of which resembles the Straits Schist. Graphitic rocks are present in this belt, but they are very rusty, splintery, sulfate-coated, slabby schist associated with hard, fine-grained quartzite, coticule rock, and nonrusty granular gneiss and schist. These are the same rocks that Martin (1970, p. 35) mapped as Hartland Unit III. The nonrusty granular gneiss and schist are lithically similar to the rocks of the Ratlum Mountain Member of the Satans Kingdom Formation of the Collinsville quadrangle and the Moretown Formation of western Massachusetts. The rusty carbonaceous schist, quartzite, and coticule rock correspond to the carbonaceous schist member of the Rattlesnake Hill Formation in Collinsville and are characteristic of the black schist units in the Hawley Formation in western Massachusetts. This is the critical belt which both Cassie and Martin (see preceding section of this report) interpreted as Straits Schist and which Martin (1970, fig. 9) then traced into his Hartland Unit II, thereby establishing his proposed correlation of Hartland II and The Straits. We do not map any Straits Schist in this belt and, therefore, believe that there is no field evidence for equating Hartland II and the Straits.

Thus, in summary, we generally agree with the mapping of Straits Schist in the northeastern and southeastern parts of the Thomaston quadrangle, but disagree with the mapping of Straits north from the town of Thomaston. We have not examined the rocks Cassie mapped as Straits in the southwestern part of the Thomaston quadrangle, but we have tentatively included them with the Straits on plate 1.

The feldspathic gneiss and intercalated amphibolite mapped by Cassie as Reynolds Bridge Gneiss in the south-central part of the Thomaston quadrangle are strikingly similar to the Collinsville Formation and are correlated with it.

Cassie's (1965, pl. 1) "undifferentiated granulite and schist" unit contains a variety of rocks, all of which have a general pre-Silurian aspect. Our reconnaissance was not sufficiently detailed to enable us to suggest correlation of any specific parts of this unit with individual units mapped in other quadrangles. From our observations in adjoining quadrangles, however, we believe that none of the rocks in the Thomaston quadrangle are any older than Middle Ordovician.

Cassie (1965) maps marble at several places in the south-central part of the Thomaston quadrangle. We have not restudied this particular area in detail, but it may be significant that all these exposures are at or near the contact between Straits Schist and Reynolds Bridge Gneiss. If the correlations for the Straits and Reynolds Bridge suggested above are correct, these exposures of marble are at least very close to the stratigraphic position of and may correlate with the Russell Mountain Formation of Massachusetts and presumably correlative rocks in the Collinsville and other quadrangles in western Connecticut.

BRISTOL QUADRANGLE

H. E. Simpson (unpub. data) has mapped the Bristol quadrangle immediately south of the Collinsville quadrangle and has kindly given us permission to incorporate some of his data on plate 1. The contacts shown are from his map, but the interpretation of the age of the rocks is ours, and he may or may not agree with it.

In essence, the rocks shown on plate 1 as Silurian and Devonian in the Bristol quadrangle are a southward extension of the rocks mapped as The Straits Schist in the Collinsville quadrangle and a northward continuation of rocks in the Southington quadrangle, discussed below, that we correlate with the Collinsville The Straits Schist. The remaining rocks in the Bristol dome have been mapped northward into the Collinsville and Taine Mountain Formations in the Collinsville quadrangle and, therefore, are correlative with the Hawley and Moretown Formations of western Massachusetts.

WATERBURY QUADRANGLE

The Waterbury quadrangle, which has been mapped by Gates and Martin (1967; see also Gates and others, 1968), is south of the Thomaston quadrangle and southwest of the Bristol quadrangle.

Both the Southington Mountain and The Straits Schist Members (stratigraphic section 7) of the Hartland Formation of the Waterbury quadrangle are graphitic pelitic schist with thin bedding and abundant graded beds. Both are similar to the Goshen Formation of southern Massachusetts. The distinction between the two members mapped in the Waterbury area was not recognized in the Thomaston and Collinsville quadrangles to the northeast, but the existence of major and minor facies changes in the Silurian and Devonian rocks of Massachusetts suggests that similar changes can be expected in Connecticut. We here correlate both the Southington Mountain and The Straits Schist Members of the Hartland Formation of the Waterbury area with the Goshen of Massachusetts.

Below the Southington Mountain and The Straits Schist Members of the Hartland Formation, Gates and Martin mapped the Hitchcock Lake Member and Unit I of the Hartland. These rocks and the Waterbury Formation we consider to be pre-Silurian. Hartland Unit I correlates with the Taine Mountain Formation, and the Hitchcock Lake Member correlates with the Collinsville Formation in the Collinsville quadrangle (Gates and Martin, 1967, pl. 1).

The Waterbury Formation is predominantly thinly to thickly layered plagioclase-quartz gneiss and granulitic gneiss with kyanite-bearing gneiss and schist and migmatitic trondhjemite and granite. Gates and Martin (1967, p. 14) suggested a Precambrian age for the Waterbury Formation based on several correlation schemes proposed by Stanley (1964, p. 43–51) which we now know are incorrect. Many of the Waterbury rocks look like some of the gray nonrusty-weathering feldspathic rocks in the thick-bedded member of the Cobble Mountain Formation, whereas some of the more granulitic parts of the Waterbury Formation resemble the Moretown Formation of Massachusetts. Although none of the similarities between the Waterbury and western Massachusetts rocks is compelling, we suggest that the Waterbury may be a facies equivalent of at least some part of the Middle Ordovician section of western Massachusetts. Alternatively, it may be equivalent to an older part of the Paleozoic section of western Massachusetts, as suggested by John Rodgers (written commun., 1971) and Gates and Martin (oral commun., 1971).

SOUTHINGTON, MOUNT CARMEL, ANSONIA, AND MILFORD QUADRANGLES

Fritts (1962, 1963a, b, 1965a, b) has mapped, from north to south, the Southington, Mount Carmel, Ansonia, and Milford quadrangles, Connecticut. In these four quadrangles, he worked out the stratigraphic section that is summarized here from his own map explanations as stratigraphic section 8.

Reconnaissance studies indicate that throughout these four quadrangles almost all the rocks mapped as Straits Schist are gray carbonaceous schist and schistose granulite generally similar to the rocks of the Straits Schist of the Collinsville area and unlike the texturally and mineralogically distinct carbonaceous schists of the Hawley Formation or Rowe Schist in Massachusetts.

A major exception to this generalization is the rocks surrounding the 2-mile-long amphibolite (mapped on pl. 1 as the southern and western edge of the northernmost belt of Ohcu) in the northwestern part of the Southington quadrangle (Fritts, 1963a). The rocks immediately north of the amphibolite are rusty-weathering fine-grained feldspathic schist similar to either the rusty schist in the thick-bedded member of the Cobble Mountain Formation or the carbonaceous schist in the Hawley Formation. These same rocks form a thin belt south of the amphibolite that appears to merge with the Hitchcock Lake Member of the Waterbury Gneiss northwest of the Southington Reservoir (pl. 1) (Fritts, 1963a). In this area, Fritts (1963a) shows the Straits wedging out between the amphibolite and the Hitchcock Lake Member. We have modified Fritts' map on plate 1 to show a smaller wedge of Straits (=Goshen) bounded on the south by Fritts' Straits-Hitchcock Lake contact and on the north by an arcuate contact 1,000 m to the north at the west edge of the quadrangle and curving to the southeast to close the wedge about 1,000 m northwest of Southington Reservoir (pl. 1) (see Fritts, 1963a). We interpret the amphibolite and the surrounding rusty-weathering feldspathic schist as pre-Silurian rocks. We consider all the remaining areas mapped by Fritts as Straits Schist to be generally correlative with the Goshen Formation, and thus Silurian and (or) Devonian in age.

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Fritts' Southington Mountain Schist contains two distinctly different groups of rocks. On Southington Mountain in the Southington quadrangle, this formation is gray carbonaceous generally well bedded schist and granulite very similar to the Straits Schist in this and other quadrangles to the north. This unit continues to the south as a thin belt between the Waterbury dome and the Larsens Pond fault to a latitude of 41°32′30″ (Larsens Pond) (Fritts, 1963a). Although Fritts was able to separate this Southington Mountain Schist from the Straits Schist west of Larsens Pond fault, we were unable to recognize the distinction and considered them to be a single unit.

The oniy other belt of Southington Mountain Schist that contains rocks similar to the Straits (and hence the Goshen) is directly west of the Derby Hill Schist in the Mount Carmel, Ansonia, and Milford quadrangles (shown as eastern belt of Straits on pl. 1). The rocks are thinly bedded graphitic schist with some quartz-rich gneiss typical of the lower part of the Goshen. In the southwest part of the Mount Carmel quadrangle (pl. 1), we have reinterpreted a line that Fritts (1963b) mapped as a staurolite isograd entirely within the Southington Mountain Schist. We believe that this line is a normal contact between probable Silurian-Devonian rocks (DSw) on the southeast and pre-Silurian rocks (Ohb and Ohc) on the northwest. The lenses of calc-silicate amphibolite along this contact are, we believe, correlative with the Russell Mountain Formation of Massachusetts. In the Ansonia quadrangle (Fritts, 1965a), we believe that the belt of quartz-rich paragneiss of the Southington Mountain (OCsq of Fritts, 1965a, but shown as Ohc on pl. 1) is pre-Silurian, and the main mass of what Fritts called the Southington Mountain Schist (OCs, Fritts, 1965a) (continuous with the Cooks Pond of Crowley, 1968, and shown on pl. 1 as the eastern belt of Straits) is Silurian-Devonian Goshen equivalent. All the presumed pre-Silurian rocks we have studied in the belt mapped as Ohc on plate 1 are rusty-weathering nongraphitic fine-grained feldspathic schist with some beds of granulite or gneiss. Some of the schists are splintery and stained with weathered sulfides. These rocks are similar to the rusty schist in the Cobble Mountain Formation or the Hawley Formation in Massachusetts. They are also similar to part of the Taine Mountain Formation in the Collinsville quadrangle.

The remaining parts of the Southington Mountain Schist in the Southington, Mount Carmel, and Ansonia quadrangles contain rusty- and nonrusty-weathering feldspathic schist and gneiss that resemble parts of the Cobble Mountain and Hawley Formations. Included in this group are the rocks mapped as Southington Mountain east of the Larsens Pond fault in the Southington quadrangle and northwest of Shelton in the Ansonia quadrangle. We generally correlate all these rocks with the Middle Ordovician section in western Massachusetts.

The Wepawaug Schist extends from the southwestern part of the Mount Carmel quadrangle (Fritts, 1963b) south into the Ansonia and Milford quadrangles. The Wepawaug correlates with the Waits River and Northfield Formations of Vermont, and thus has been assigned a Silurian and Devonian age (Fritts, 1962). The Wepawaug is distinctly different from the Straits Schist in bedding characteristics, the presence of calcareous beds, and texture. It resembles much of the Waits River Formation of Vermont (Doll and others, 1961) and parts of the Conway Formation in the Williamsburg quadrangle, Massachusetts (Willard, 1956). The Conway Formation in the Williamsburg area and the Goshen Formation in the Goshen and Worthington quadrangles (pl. 1) to the west are now thought to be facies equivalents. The Straits and the Wepawaug in southern Connecticut may also be coeval.

In the northwestern part of the Mount Carmel quadrangle, Fritts has mapped lenses of marble and hornblende-andesine-clinozoisite-sphene-calcite amphibolite at the eastern contact of the Straits Schist. He has also mapped lenses of these same rocks in the northwestern part of the Southington quadrangle in and at the contacts of the Straits Schist in the area of our proposed infold of pre-Silurian rocks. We tentatively propose that these lenses of marble and calc-silicate amphibolite are correlative with the Russell Mountain Formation of Massachusetts.

The remaining pre-Triassic formations delineated by Fritts in the Southington, Mount Carmel, Ansonia, and Milford quadrangles appear to be correlative with the Ordovician section of western Massachusetts. In the Southington quadrangle, Fritts separated the Hitchcock Lake Member from the main body of the Waterbury Gneiss. This member contains nonrusty- and rusty-weathering feldspathic schist and gneiss and some beds of coticule. The schist and gneiss are lithically similar to the Collinsville Formation in the Collinsville quadrangle and the thick-bedded member of the Cobble Mountain Formation in the southern part of western Massachusetts. In the Waterbury quadrangle just to the west, the main mass of the Waterbury has been subdivided by Gates and Martin (1967) into, from oldest to youngest, the Waterbury Formation and Unit I and the Hitchcock Lake Members of the Hartland. As we indicated in our discussion of the Waterbury quadrangle (p. 36), we believe that this section is largely equivalent to the Moretown and Hawley Formations in western Massachusetts. More detailed correlation of the Waterbury Gneiss in the Southington quadrangle must await additional study of these rocks.

The Derby Hill Schist has been mapped by Fritts (1963b; 1965a, b) in northeast-trending belts on both sides of the Wepawaug syncline. From our study of the western belt, we have concluded that Fritts' Derby Hill contains two different kinds of rock that we would assign to two different parts of the stratigraphic section. The Derby Hill Schist south of the Housatonic River in the Ansonia quadrangle (pl. 1) was divided into two members by Fritts (1965a, b). The Oronoque Member south of the top of Coram Hill (about 1.2 km southwest of the Housatonic River, pl. 1) (Fritts, 1965a) consists of slabby to thinly laminated quartz-rich granulite or gneiss with some schist and is very similar to the Moretown Formation of Massachusetts. South of Long Hill about 2 km south-southwest of Coram Hill, the other member of Fritts' Derby Hill consists of many of the same Moretown-like rocks. North of Coram and Long Hills, both members of the Derby Hill consist of sheared graphitic schist that is indistinguishable, except in degree and type of deformation, from the Wepawaug rocks to the east and is radically different from the Derby Hill rocks to the south. Although Fritts correlated all of his Derby Hill with the Moretown, we agree with this correlation only for the Derby Hill rocks south of Coram Hill. A nearly continuous exposure across the Derby Hill Schist on State Route 110 on the southwest side of the Housatonic River (1 km south of the junction of the Housatonic and Naugatuck Rivers, pl. 1) consists of dark-gray, highly carbonaceous schist typical of the Wepawaug except for two tabular masses about 1–3 m thick. The light-gray to greenish-gray quartz-rich granulite and schist of the Derby Hill to the south is absent, except for the two tabular bodies. The significance of these sheared Wepawaug-like rocks is considered in detail in our discussion of the Westport quadrangle and vicinity (p. 47).

We did not study for this report the Allingtown Metadiabase, the Maltby Lakes Volcanics, and the Derby Hill Schist on the southeastern side of the Wepawaug syncline in the Ansonia and Milford quadrangles. From earlier reconnaissance, however, we consider these units similar to rocks mapped by Crowley (1968) in the Bridgeport quadrangle and mapped by Burger (1967) in the western part of the New Haven quadrangle, and on this basis we would correlate them with the Ordovician section of western Massachusetts. Whole-rock Rb–Sr analysis of the Maltby Lakes Volcanics gives an isotopic age of 460 m.y. (Armstrong and others, 1970), which is compatible with our stratigraphic correlations.

The Prospect and Ansonia Gneisses are widely distributed throughout the four quadrangles studied by Fritts. He interprets both of these units as metamorphosed intrusive rocks and assigns a Devonian age to them, although he admits that they may be Ordovician. Crowley (1968), however, interpreted these to be Ordovician volcanic rocks, on the basis of another structural interpretation for the southeastern part of western Connecticut. A Devonian age would be likely if all the rocks mapped as Southington Mountain were in fact correlative with the Goshen of western Massachusetts. According to our interpretation of the Southington Mountain Schist, however, the Prospect and Ansonia Gneisses are found only with rocks that we correlate with the pre-Silurian section to the north. Neither the Prospect nor the Ansonia are reported in the Straits or those parts of the Southington Mountain that we consider equivalent to the Goshen Formation. These relationships suggest that the Prospect and Ansonia are pre-Silurian rocks which were either intruded during the Taconic orogeny or were deposited as volcanic material during the Middle Ordovician, but which are almost surely pre-Goshen (Straits) in age. "Samples from the Prospect Formation and Ansonia Gneiss form an isochron with an intercept (Sr^{87}/Sr^{86}) of 0.710 and a slope corresponding to an age of 410 m.y. (Silurian)" (Armstrong and others, 1970, p. 22). According to Harland and others (1964), this age is too young for the Ordovician (435–500 .m.y.), but the Prospect and the Ansonia could still have been emplaced before deposition of the Straits.

NAUGATUCK QUADRANGLE

Carr (1960) mapped the Naugatuck quadrangle, Connecticut (pl. 1), and subdivided the metamorphic rocks from oldest to youngest, into the Waterbury Gneiss, Hartland Formation, and Orange Phyllite. He further subdivided the Hartland Formation into, from oldest to youngest, The Straits Schist Member, an undifferentiated Hartland unit, and a quartzitic member. These rocks are described here in stratigraphic section 9.

Throughout the quadrangle, most of the rocks mapped by Carr as The Straits Schist Member are muscovite-rich schist with the graphitic sheen that typifies The Straits to the north and east, although most exposures are coarser grained and less distinctly bedded. The presence in some exposures of rocks similar to The Straits in the Collinsville quadrangle suggests that these coarser schists are merely a facies, either sedimentary or metamorphic, of the somewhat finer grained and more distinctly bedded Straits schists.

At a few places near the contact with the undifferentiated Hartland, Carr (1960) mapped some graphitic schist as The Straits, which, because of its extremely rusty sulfidic weathering and slabby splintery texture, resembles the graphic schist of the Hawley Formation in Massachusetts more than the typical rocks of The Straits Schist. These rocks, which we consider pre-Silurian and correlative with Stanley's (1964) Rattlesnake Hill Formation and the Hawley Formation, appear to be minor and local at the base (Carr's top) of The Straits, as mapped by Carr (1960).

The rocks which Carr mapped as undifferentiated Hartland southeast of his The Straits are continuous to the northeast with rocks mapped by Fritts (1963a) as Southington Mountain and to the southwest with rocks mapped by Fritts (1965a) as Prospect Gneiss. The apparent explanation for this discrepancy is that Fritts interpreted the Prospect as an intrusive igneous rock and mapped those areas that contained predominantly igneous-looking gneisses as Prospect regardless of the metasedimentary rocks with which they were associated. Carr (1960, pl. 1 and p. 17), on the other hand, interpreted the Prospect as a metamorphic derivative of part of the Hartland Formation. We have not studied this particular area sufficiently to resolve the problem.

The Waterbury Gneiss of the Naugatuck quadrangle is continuous with the Waterbury Formation of the Waterbury quadrangle to the north (Gates and Martin, 1967). It contains rocks that closely resemble the Collinsville and Taine Mountain Formations in the Collinsville quadrangle (Stanley, 1964) with which we correlate them.

The Prospect Gneiss mapped by Carr (1960, pl. 1) west of the long northeast-trending dolerite dike (shown as the Southington Mountain fault on pl. 1) has been reinterpreted as Collinsville Formation by Crowley (1968, pl. 4) because it is identical to many of the feldspathic two-mica gneisses of the Collinsville.

In the southeast corner of the Naugatuck quadrangle, gray graphitic schist identical with most of Fritts' (1963b) Wepawaug has been mapped as Orange Phyllite. The northwest boundary of the Orange with the quartzitic member of the Hartland is continuous with the staurolite isograd in the Southington Mountain Formation to the northeast (Fritts, 1963b). As discussed in the preceding section (p. 38), we believe that all the metamorphic rocks southeast of the staurolite isograd in the Mount Carmel quadrangle are Silurian-Devonian Wepawaug and should not have been subdivided. Thus, we correlate Carr's Orange Phyllite with the Wepawaug and assign to it a Silurian and Devonian age.

LONG HILL AND BRIDGEPORT QUADRANGLES

The stratigraphic sequence proposed by Crowley (1968) for the Long Hill and Bridgeport quadrangles (pl. 1) (stratigraphic section 10) is based on the assumptions that the older rocks are in the cores of the Waterbury and other domes and that the youngest rocks form the trough of the Bridgeport syncline. This sequence differs considerably from that proposed by Fritts (1962) that we discussed above (p. 37) for the southeastern part of the western Connecticut. Dieterich (1968a, b) later proposed for the southeastern belt a third scheme which is discussed in a subsequent part of this report (p. 47).

Crowley (1968) stated that the rocks become older to the northwest from the axis of the Bridgeport syncline according to the sequence Prospect-Southington Mountain-Trap Falls-The Straits-Collinsville-Newtown. Crowley and Fritts disagree in their interpretation of the rocks southeast of the East Derby fault (pl. 1). Because Fritts did not recognize the Bridgeport syncline, he placed the sequence Derby Hill-Maltby Lakes-Wepawaug on top of the Southington Mountain, in which he included most of the rocks between the western belt of Straits and the East Derby fault (pl. 1). Subsequent work by Crowley (1968) demonstrated the existence of the Bridgeport syncline and showed that The Straits Schist reappears on the southeastern limb (as Cooks Pond Schist, in Crowley, 1968, pl. 1; shown here as eastern belt of Straits Schist on pl. 1) in a belt mapped as Southington Mountain by Fritts (1965a). Southeast of the eastern belt of Straits (pl. 1) and northwest of the western belt of Straits the rocks are totally different. Crowley placed the rocks to the southeast below those to the northwest. He further eliminated the Wepawaug syncline, choosing to interpret this belt as a homoclinal sequence. Furthermore, he revived the names Orange Formation (which included the Derby Hill and Wepawaug of Fritts) and Milford Formation (which included the Savin Schist, and the Allingtown and Maltby Lakes Volcanics as used by Burger, 1967).

Our reconnaissance in the Long Hill and Bridgeport quadrangles has resulted in substantial disagreement with Crowley's correlation and sequence. We would reverse the stratigraphic sequence in the Bridgeport syncline and correlate the rocks between the three belts of Straits with the dome rocks northwest of the western belt of Straits. We consider the Bridegport syncline to be an anticlinal synform, as was first formally suggested by Dieterich (1968a, b). Furthermore, we disagree with Crowley's homoclinal sequence interpretation of the rocks southeast of the eastern belt of Straits (Cooks Pond Schist). Instead, we favor Fritts' (1965a, b) and Burger's (1967) interpretation that the Wepawaug Schist forms a syncline which is bordered on either side by rocks of Ordovician age.

The rocks that Crowley mapped as the lower member of The Straits Schist are all identical to the thin-bedded part of the Goshen Formation. The marble and amphibolite between The Straits and the Collinsville Formation to the west may well be correlative with the Russell Mountain Formation of Massachusetts.

The upper member of The Straits in the Long Hill quadrangle north of the latitude of the Trap Falls Reservoir (2.5 km northwest of the southeast corner of the quadrangle) is for the most part lithically similar to and, we believe, correlative with the Goshen of Massachusetts. However, the rocks surrounding the marble lens north of the Housatonic River near the type locality of the upper member (Crowley, 1968, pl. 2; body of Russell Mountain in the northeast corner of the Long Hill quadrangle, pl. 1) are fine-grained splintery sooty schist far more similar to the carbonaceous schist member of the Rattlesnake Hill Formation and the black schist in the Hawley than to the Goshen (pl. 1). We correlate these rocks with the Hawley and suggest that Crowley may have included similar rocks elsewhere in his upper member of The Straits.

South of the latitude of Trap Falls Reservoir in the Long Hill quadrangle and continuing south into the Bridgeport quadrangle, brown- to rusty-weathering, nongraphitic feldspathic schist and gneiss with minor thin beds and lenses of hard calc-silicate gneiss make up most outcrops of the upper member of The Straits Schist that we examined. We correlate these rocks with the rusty- and brown-weathering rocks in the Cobble Mountain Formation and not with the younger Goshen Formation. Some outcrops in the upper member of The Straits look like the rusty schist of part of the Taine Mountain Formation in the Collinsville quadrangle.

In part of the central belt of The Straits (pl. 1), Crowley (1968, pl. 2) mapped a narrow belt of thinly bedded rusty-weathering schist with a graphitic sheen as the staurolite schist member of the Southington Mountain Formation. Although he recognized (1968, p. 28) the close similarity between this unit and the lower member of The Straits, he did not correlate them. After carefully studying outcrops in this belt, we correlate the western part of this belt (west of the sillimanite isograd (Crowley, 1968, pl. 2)) with the Goshen Formation and so map it on plate 1. The eastern part of the belt (east of the sillimanite isograd) is nongraphitic feldspathic schist and gneiss that we correlate with the Cobble Mountain Formation (shown as Ohc on pl. 1). The quartzite, marble, and amphibolite that Crowley mapped at and near the contact of the staurolite schist member of the Southington Mountain are mapped as the Russell Mountain Formation on plate 1.

Crowley (1968) correlated the Cooks Pond Schist (eastern belt of Straits on pl. 1) with The Straits Schist. We agree with this correlation. The Cooks Pond is rusty weathering and thinly bedded, and the foliation surfaces are covered with thin films of graphite so typical of the Straits and the Goshen.

In summary, there appear to be at least three separate belts of rocks in the Long Hill-Bridgeport area that we would correlate with the Goshen Formation of western Massachusetts: the western belt of Straits that Crowley mapped as the lower member of The Straits and to which we would add part of the upper member in the Long Hill quadrangle, a central belt in the Bridgeport quadrangle that Crowley mapped as the staurolite schist member of the Southington Mountain Formation, and an eastern belt that Crowley mapped as Cooks Pond Schist.

We correlate all the other metasedimentary and metavolcanic rocks in the Long Hill and Bridgeport quadrangles with the pre-Silurian section of western Massachusetts. The metasedimentary rocks of the Trap Falls and Southington Mountain (excluding part of the staurolite schist member, as discussed on p. 44) are brown- to rusty-weathering, nongraphitic feldspathic schist, granulite, and gneiss with minor beds of hard calc-silicate rock and coticule. We correlate these rocks with the Cobble Mountain Formation in Massachusetts. Many of the rocks of the Trap Falls and Southington Mountain Formations are also similar to part of the Taine Mountain Formation which we correlate with the Moretown Formation to the north. The separate units of metasedimentary rocks in the Shelton facies of the Trap Falls Formation in the Bridgeport quadrangle are coarse-grained rusty-weathering schist with round porphyroblasts of garnet 2–3 cm in size (Crowley, 1968, p. 23). These rocks resemble the bumpy garnet schists in the upper member of the Moretown Formation in most of western Massachusetts (see p. 6). Similar rocks are also present in the banded schist member of the Southington Mountain Formation. The biotite gneiss member of the Southington Mountain is similar to the nonrusty units in the thick-bedded member of the Cobble Mountain Formation. It also resembles parts of the Collinsville Formation in the Bristol dome in the Collinsville quadrangle.

The garnet-bearing granitic gneiss mapped by Fritts (1965a) as the Ansonia Gneiss in the west-central part of the Ansonia quadrangle composes a major part of Crowley's Shelton facies of the Trap Falls Formation and appears as a distinct layer in the northwestern facies of this same unit. Crowley observed that the granitic gneiss was interlayered on all scales with metasedimentary rocks that Fritts had mapped as Southington Mountain. Crowley, therefore, separated the granitic gneiss and schist from the main mass of Fritts' Southington Mountain Formation and established a new unit, the Trap Falls Formation. Although Fritts (1965a) interpreted the Ansonia Gneiss as an intrusive rock, it is equally possible it had a volcanic origin as suggested by Crowley (1968, p. 25). Our reconnaissance can contribute nothing to this particular argument other than the observation that the granitic gneiss is intercalated with rocks that we would assign to the stratigraphic interval between the upper part of the Moretown and the top of the Hawley Formation in Massachusetts. As we pointed out (p. 38), the Southington Mountain Formation south of Waterbury is totally different from the Southington Mountain at the type locality in the Southington quadrangle which we consider to be equivalent to the Goshen of Massachusetts.

The Prospect Formation as mapped by Crowley (1968) consists of four members. Two are biotite-(hornblende)-feldspar gneisses with large porphyroblasts of microcline that are compositionally somewhat similar to a dellenite (Crowley, 1968, p. 39) and two are metasedimentary. We consider the metaigneous rocks to be stratigraphically equivalent to the Collinsville Formation west of the western belt of Straits. Although microcline porphyroblasts are not present in the Collinsville Formation, they are a conspicuous feature of the Newtown Gneiss which is intimately associated with the Collinsville in the Long Hill and Southbury (Robert Scott, oral commun., 1969) quadrangles. This gneiss has been mapped over a large area south of the Housatonic River in the south-central part of western Connecticut (George Heyl and Robert Scott, oral commun., 1969; Stanley, unpub. data) where it appears to be at least in part intrusive. Although Crowley (1968, p. 39) interpreted porphyroblastic gneiss of the Prospect as metamorphosed volcanic rock, Fritts (1962) thought they were metamorphosed intrusives. We suggest that the Newtown Gneiss and the metaigneous rocks of the Prospect are genetically related and that these units may represent discordant intrusives in the south-central part of western Connecticut and an extrusive or possibly a concordant intrusive in the southwestern belt.

The metasedimentary units (Golden Hill Schist Member and the calcareous member) in Crowley's Prospect Formation are identical with a garnetiferous schist unit in the Newtown quadrangle (Stanley, unpub. data). The Golden Hill is lithically similar to the Ratlum Mountain Member of the Satans Kingdom Formation in the Collinsville quadrangle. We propose this correlation.

WESTPORT QUADRANGLE AND VICINITY

Dieterich (1968a, b) mapped the Westport quadrangle (pl. 1) just west of the Bridgeport quadrangle and also reinterpreted the regional stratigraphy and structure in the southeastern part of western Connecticut.

Dieterich recognized three belts of The Straits Schist in the southeastern part of western Connecticut: a western belt continuous with the main mass of The Straits in western Connecticut, a thin central belt which connected with the staurolite schist of the Southington Mountain as mapped by Crowley, and an eastern belt which Crowley had mapped as Cooks Pond. These belts are so labeled on plate 1. He also mapped a small island of The Straits just east of the central belt in the Westport quadrangle (pl. 1). We have examined all these belts and agree with Dieterich's designation; we herein correlate them with the Goshen in Massachusetts.

Dieterich (1968a, p. 3–5) recognized two other formations in the Westport area: the Prospect Formation, including the upper and Golden Hill Members, and the Fairfield Formation. The Prospect is continuous with the Prospect mapped by Crowley to the east and north. The Fairfield is a new unit that was divided by Dieterich into two members. The upper member contains banded schist and gneiss with a distinctive sequence of quartzite, marble, and amphibolite. Dieterich showed rather convincingly that the detailed stratigraphic sequence in the upper member is repeated on both sides of the belts of The Straits in many places in the southeastern part of western Connecticut. At the top of the Fairfield Formation at the contact with The Straits Schist is a discontinuous bed of massive quartzite as much as 13 m thick. We correlate this quartzite with the Russell Mountain Formation of Massachusetts because of its lithology and stratigraphic position. The calc-silicate rock, marble, and quartzite lower in the Fairfield are intercalated with nongraphitic brown-weathering feldspathic schist and gneiss that resemble the rusty schist in the Cobble Mountain Formation and are unlike the rocks of the Goshen Formation. If our correlations are correct, marble and quartzite become far more abundant in the upper part of the pre-Silurian eugeosynclinal section in southwestern Connecticut than they are to the north in western Massachusetts. An alternative but, to us, less appealing interpretation is that the Russell Mountain Formation thickens to the south and includes some pre-Silurian-like schist not presently recognized in the Russell Mountain to the north.

Although the Fairfield Formation is continuous with the upper member of The Straits and the Southington Mountain Formation in the Bridgeport and Long Hill quadrangles, Dieterich selected another name because he believed (1) that the upper member of The Straits and the Southington Mountain were the same unit (Crowley separated the two) and (2) that the Southington Mountain Formation at the type locality in the Southington quadrangle was totally different from the Southington Mountain mapped by Fritts and Crowley east and south of the Waterbury dome. The noncarbonaceous brown rocks that Crowley (1968) and Fritts (1965a, b) call Southington Mountain (excluding the gray carbonaceous staurolite schist of the Southington Mountain of Crowley, 1968) are not the same unit as the gray carbonaceous rocks Fritts (1963a) mapped on Southington Mountain in the Southington quadrangle, which we correlate with the Goshen Formation to the north.

Dieterich also correlated the Fairfield Formation east of the main belt of The Straits with the Waterbury, Prospect, and Collinsville Formations to the west in the Long Hill (Crowley, 1968) and Naugatuck (Carr, 1960) quadrangles. Although these formations appear to contain more volcanic material than the Fairfield Formation, we generally agree with this correlation.

In considering the geology east of the eastern belt of Straits (Cooks Pond of Crowley, 1968), Dieterich accepted Burger's (1967, p. 4) and Fritts' (1965a, b) correlation of the Derby Hill Schist and the Maltby Lakes Volcanics on the west side of the Wepawaug syncline with the Savin Schist, Allingtown Volcanics, and Maltby Lakes Volcanics on the east side, the Wepawaug Schist forming the trough of the syncline. Dieterich placed this sequence on top of The Straits primarily because of the lack of stratigraphic symmetry across the belt of Cooks Pond Schist (eastern belt of Straits on pl. 1). As discussed (p. 40), we correlate the Derby Hill south of Coram Hill in the Ansonia quadrangle (Fritts, 1965a) with the Moretown Formation of western Massachusetts. The Maltby Lakes Volcanics are equivalent to the Hawley Formation. The Wepawaug Schist is lithically similar to the Waits River Formation of southernmost Vermont (Doll and others, 1961) and adjacent Massachusetts (Hatch and Hartshorn, 1968). The Straits and Wepawaug may be facies equivalents of each other just as the Goshen and Waits River may be in western Massachusetts.

The lack of stratigraphic symmetry across the eastern belt of Straits (Cooks Pond Schist) requires an explanation in our proposed correlation. The Cooks Pond lies between the Bridgeport synform (a stratigraphic syncline according to Crowley (1968), an anticlinal-synform according to Dieterich (1968a, b), the Bridgeport syncline on pl. 1) to the west and the Wepawaug syncine (a stratigraphic syncline according to everyone but Crowley (1968)) to the east. Two possible explanations come to mind. In the first explanation, the Cooks Pond would represent a synclinal antiform separating the two synforms mentioned above. This solution, however, generates a stratigraphic problem. Dissimilar lithic types on both sides of the Cooks Pond require either an unconformity or an abrupt facies change which must occur somewhere above the present surface of the earth. Neither of these alternatives can be demonstrated. In the second explanation, the eastern contact of the Cooks Pond with the Derby Hill would be a fault. In August 1970, John Rodgers, Stewart Clark, Jr., and the authors found abundant evidence for such a fault in the Bridgeport, Ansonia, and Mount Carmel quadrangles. As discussed on page 40, most of the Derby Hill Schist south of Long Hill in the southwest corner of the Ansonia quadrangle is lithically similar to the Moretown Formation of western Massachusetts. Between Long Hill and Coram Hill 2 km to the north in the Ansonia quadrangle, the Oronoque Member is the only unit of the Derby Hill that resembles the Moretown; the main part of the Derby Hill as mapped (Fritts, 1965a) is dark-gray graphitic schist with quartz-rich laminae totally unlike the Moretown. The dark graphitic schist becomes the dominant rock type north of Coram Hill and is the unit that Fritts (1965a) designated as the type Derby Hill in Derby north of the Housatonic River. Fritts (1965a) also reported that the Derby Hill north of the Housatonic is highly sheared. We propose that the dark graphitic schist in the Derby Hill north of Long and Coram Hills is actually a highly sheared part of the Wepawaug Schist. Evidence for this proposal can best be seen along Route 110 in Sunnyside just west of the Housatonic River in the Ansonia quadrangle. Starting from a latitude of about 41°17′27″ on Route 110 in rocks mapped by Fritts (1965a) as Wepawaug, and traversing northwest, one sees outcrops of typical Wepawaug Schist pass into outcrops of graphitic schist that are highly sheared and deformed. Although Fritts (1965a) mapped these sheared rocks as Derby Hill, they are lithically indistinguishable from the Wepawaug immediately to the east and quite unlike the Derby Hill south of Long Hill. Approximately 100 m northwest of the Derby Hill-Wepawaug contact (as drawn by Fritts, 1965a), the sheared graphitic schist contains large discontinuous lenses of typical Moretown granulites. These we interprete as tectonic slivers emplaced along a zone of intense movement. Thus, as presently mapped, the Derby Hill contains two distinct "facies": a pinstriped schist-quartz granulite facies which we correlate with the Moretown Formation; and a variably sheared dark graphitic schist with thin quartz-rich laminae, which we consider a tectonic facies of the Wepawaug Schist and, therefore, Silurian and Devonian in age. It appears that the proposed fault, here called the East Derby fault, on the east side of the Cooks Pond forms a narrow zone at the contact between the Cooks Pond and Derby Hill south of Long Hill; to the north the fault widens and may well involve most of the belt mapped as Derby Hill north of the Housatonic River and shown on plate 1 as the eastern belt of Straits. In the Bridgeport quadrangle, the rocks in the eastern belt of The Straits are much like Goshen rocks in Massachusetts. North of the Bridgeport quadrangle, they are more like the Wepawaug rocks to the east, and so they are mapped on plate 1. Their boundary on plate 1 is a facies boundary.

In summary, the chief modification we propose in Dieterich's section is to consider the Derby Hill-Maltby Lakes-Wepawaug sequence stratigraphically equivalent to, rather than above, the Prospect-Fairfield-The Straits sequence. Except for the addition of a fault along the Cooks Pond belt, we essentially agree with the overall structure that Dieterich (1968a, p. 9) proposes for this area.

SUMMARY DISCUSSION OF CORRELATIONS

In the preceding parts of this report we first described the sequence of rocks east of the Precambrian Berkshire massif that have recently been traced south from Vermont across most of western Massachusetts. We also described some major north-south facies changes in these rocks in the vicinity of Blandford, Mass. We then presented and discussed the stratigraphic sections described by various geologists for individual quadrangles and groups of quadrangles along the same belt of rocks in southernmost Massachusetts and across the eastern part of western Connecticut. To bring together the correlations proposed in the foregoing pages, we now propose to trace the major stratigraphic intervals southward across Massachusetts and Connecticut and to summarize, using the correlation chart presented as plate 2, our interpretation of the changes in facies and nomenclature affecting the rocks in these intervals between southernmost Vermont and Long Island Sound.

The fundamental difference between the stratigraphic sections presented at the end of this report and the columns of the correlation chart on plate 2 is that the stratigraphic sections present the units in the sequence proposed by the authors of the reports cited, whereas plate 2 presents the units in the sequence we herein propose. The following discussion should be read in conjunction with plate 2.

The albitic schists of the Hoosac Formation of Vermont have been traced continuously across western Massachusetts to latitude 42°07′30″ by Hatch and coworkers and by S. A. Norton in the quadrangles to the west of Hatch's mapping (Norton, 1967; 1971b). Schnabel (in Hatch and others, 1968) has mapped these rocks south to 41°52′30″ as Unit 1 (Units 9–13 of Schnabel, 1971) and has correlated them with both the Hoosac Formation of Massachusetts and the Waramaug Formation of Connecticut. At the south end of the Berkshire massif Gonthier (1964) mapped this same group of rocks as Waramaug Formation. More recently, Martin (1970) has also applied the name Waramaug to these same rocks in the Torrington quadrangle.

The green schists, gray schists, and amphibolites of the Rowe Schist in Massachusetts are the southward continuation and stratigraphic correlatives of the Pinney Hollow, Ottauquechee, and Stowe Formations of Vermont (Hatch and others, 1966). Across Massachusetts, the Rowe consists of many mapped lenses of three constituent lithologies. South of Blandford, Mass., however, the Rowe consists only of a lower gray carbonaceous schist unit and an upper green noncarbonaceous schist unit. We have traced these two units about 6 km south of latitude 42°07′30″ in the West Granville quadrangle where they are included in Unit 2 (Schnabel, in Hatch and others, 1968) ; south of this point we do not know the detailed course of these units until we again recognize them about 1.5 km north of the Collinsville quadrangle, Connecticut, where they are apparently included in Unit 7 (Schnabel, in Hatch and others, 1968). In the Collinsville quadrangle, these rocks are the rusty schist and the kyanite schist members of the Slashers Ledges Formation, plus part of the Breezy Hill Member of the Satans Kingdom Formation.

West of the Collinsville quadrangle, rocks continuous with the Slashers Ledges Formation have been mapped as part of Hartland Unit II in the Torrington quadrangle by Martin (1970).

The pinstriped granulites of the Moretown Formation of Massachusetts are continuous with the Moretown Member of the Missisquoi Formation of Doll, Cady, Thompson, and Billings (1961) of Vermont. The Moretown gradually thins across Massachusets and apparently pinches out, or nearly so, at about the southern end of the Blandford quadrangle in Massachusetts. Very similar rocks have been mapped as Unit 3 by Schnabel (in Hatch and others, 1968) in the West Granville and New Hartford quadrangles, so the unit apparently reappears or widens out again in this area. Moretown-like rocks of uncertain stratigraphic position have also been mapped locally by Schnabel as Units 8 and 7. Similar rocks form a distinctive unit above the Slashers Ledges Formation in the Collinsville quadrangle that Stanley (1964) mapped as part of the Breezy Hill Member and the Ratlum Mountain Member of the Satans Kingdom Formation. We believe these rocks to be a southern equivalent of the Moretown. As discussed in an earlier section of this report (p. 28), we now believe that the Taine Mountain Formation in the domes of the Collinsville area is an eastern facies of the Satans Kingdom Formation.

Hartland Unit I as mapped in the Torrington (Martin, 1970) and Waterbury (Gates and Martin, 1967) quadrangles is, at least in part, a southwestern continuation of the Moretown. As previously discussed, the Taine Mountain Formation is identical to Hartland Unit I, and the Ratlum Mountain Member of the Satans Kingdom Formation is considered to be a central more schistose facies of these two units (fig. 3). Some of the rocks of Hartland Unit III in the Torrington quadrangle and the Waterbury Formation in the Waterbury quadrangle are probably also equivalent to the Moretown. In the Thomaston quadrangle these rocks are mapped in the undifferentiated granulite and schist unit (Cassie, 1965).

To the south again, in the Southington and Mount Carmel quadrangles, generally similar rocks apparently at the stratigraphic position of the Moretown have been mapped as part of the Waterbury Gneiss in the eastern part of the Waterbury dome. In the Ansonia and Milford quadrangles, the rocks mapped as Derby Hill Schist, including the Oronoque Member, south of Long Hill and Coram Hill and southeast of the Wepawaug Schist belt are lithically and stratigraphically correlative with the Moretown.

In the Naugatuck quadrangle (Carr, 1960), the lower parts of the Waterbury Gneiss may include rocks at the Moretown position. Similarly, in the Long Hill quadrangle, the lowest parts of the Newtown Gneiss may include rocks at the Moretown position.

In the Bridgeport quadrangle, Crowley (1968) has mapped as the Oronoque and Derby Hill Members of the Orange Formation the southwestern continuation of the belt of Moretown-like rocks that Fritts (1965a, b) mapped as Derby Hill Schist. West of the Cooks Pond Schist belt the Golden Hill Schist and calcareous members of the Prospect Formation (Crowley, 1968) are a western facies of the Oronoque and Derby Hill Members of the Orange, and are thus in the Moretown position. Finally, in the eastern part of the Westport quadrangle, Dieterich (1968a, b) mapped a continuation of Crowley's Golden Hill Schist and calcareous members as the Golden Hill Member of the Prospect.

The southward continuation of the Barnard Volcanic and carbonaceous schist members of the Missisquoi Formation of southeastern Vermont are mapped as the Hawley Formation in Massachusetts. As described in the first part of this report, the black schist and metavolcanic rock of the Hawley pass southward by a change of facies near the village of Blandford, Mass., into a sequence of schists herein named the Cobble Mountain Formation. Although we have traced the thin-bedded member of the Cobble Mountain only a few kilometers south of the Blandford quadrangle into the West Granville quadrangle, the thick-bedded member continues across the West Granville and New Hartford quadrangles largely as Unit 7 of Hatch, Schnabel, and Norton (1968). In the Collinsville quadrangle, these rocks are the feldspathic schist member of the Rattlesnake Hill Formation (Stanley, 1964). The carbonaceous schist member of the Rattlesnake Hill is a southern equivalent of the lower part of the Hawley and Cobble Mountain Formations to the north (fig. 2).

In the Heath quadrangle in northernmost Massachusetts, the gneiss in the core of the Shelburne Falls dome was interpreted as a coarser, more gneissic facies of the generally more mafic, finer grained, more schistose metavolcanic rocks of the Hawley Formation to the west (Hatch and Hartshorn, 1968). Similarly, we now interpret the rocks of the Collinsville Formation as mapped by Stanley (1964) inside the domes of the Collinsville and nearby areas to be a more volcanic facies of the Rattlesnake Hill Formation outside the domes. The Hitchcock Lake Member of the Hartland Formation as mapped by Gates and Martin (1967) and the Reynolds Bridge Gneiss of Cassie (1965) are lithically similar to and correlative with the Collinsville Formation.

Southwest of the Collinsville quadrangle the Rattlesnake Hill Formation is included in Hartland Unit III and the northwestern 300 m of The Straits Schist by Martin (1970) in the Torrington quadrangle. Cassie (1965) in the Thomaston quadrangle included these rocks in his undifferentiated granulite and schist unit, whereas the equivalents of these rocks may be mapped as the upper part of the Waterbury Formation in the Waterbury quadrangle (Gates and Martin, 1967).

Fritts' Southington Mountain Schist east of the Larsens Pond fault in the Southington quadrangle (Fritts, 1963a) and west of the eastern belt of Straits (pl. 1) in the Mount Carmel quadrangle (Fritts, 1963b) and his Prospect Gneiss in these two quadrangles are the southern reappearance of the Cobble Mountain rock type with some black schist more typical of the Hawley. These rocks are shown as Hawley and correlative rocks on plate 1. The Hitchcock Lake Member of the Waterbury in the Southington quadrangle is lithically identical to the Sweetheart Mountain Member of the Collinsville Formation and the thick-bedded member of the Cobble Mountain Formation. The Prospect Gneiss in these two quadrangles occupies the stratigraphic position of the Hawley.

In the Ansonia and Milford quadrangles (Fritts, 1965a, b), all the Southington Mountain Schist, except for the belt immediately west of the East Derby fault (pl. 1), looks like parts of the Cobble Mountain Formation and is probably equivalent to the Hawley. Many rocks of this Southington Mountain do, however, look like parts of the Taine Mountain Formation, which is equivalent to the Moretown in western Massachusetts. It is possible that equivalents of the Moretown and Hawley are involved in small isoclinal folds in this area. To the southeast in these quadrangles, the Maltby Lakes Volcanics appear to be lithically equivalent to the volcanic facies of the Hawley and to be in the same stratigraphic position as the main mass of volcanic rocks in the Hawley in Massachusetts.

In the Naugatuck quadrangle, the quartzitic member of the Hartland, most of the undifferentiated Hartland, the upper part of the Waterbury Gneiss, and the Prospect Gneiss as mapped by Carr (1960) are in the Hawley stratigraphic position.

In the Long Hill quadrangle, the Collinsville Formation, as mapped by Crowley (1968), is the gneissic facies of the Hawley. The Trap Falls and Southington Mountain Formations are, in part, lithically similar to the thick-bedded member of the Cobble Mountain Formation. The Prospect Formation is continuous with the Prospect to the east, and we correlate the Newtown Gneiss with it, although part of this unit appears to be intrusive west of the domes in the central part of western Connecticut.

In the Bridgeport quadrangle, the banded schist member of the Southington Mountain, the Trap Falls Formation, and the upper member of The Straits Schist, as mapped by Crowley (1968), appear to be a Cobble Mountain-like facies of the Hawley. In our reinterpretation, the Pumpkin Ground and Beardsley Gneiss Members of the Prospect occupy the lower part of the Hawley interval in this area.

In the Westport area, the upper member of the Prospect, as mapped by Dieterich (1968a, b), is the same as Crowley's Pumpkin Ground and Beardsley Gneiss Members of the Prospect, whereas the Fairfield Formation is a continuation of the upper member of The Straits, Trap Falls, and biotite gneiss of the Southington Mountain as mapped by Crowley and is shown as Hawley on plate 1.

The Russell Mountain Formation of Massachusetts, although about 100 km south of the Shaw Mountain Formation of Vermont, has been correlated with the Shaw Mountain (Hatch, Stanley, and Clark, 1970). South of the Blandford and Woronoco quadrangles, similar rocks at this same stratigraphic position have been mapped as Unit 6 in the Southwick and adjacent quadrangles by Schnabel (in Hatch and others, 1968) and as an unnamed calc-silicate and quartzite unit in the Collinsville quadrangle by Stanley (1964). This thin unit was apparently not recognized by Martin (1970) in the Torrington quadrangle but was mapped as patches of unnamed marble and amphibolite by Cassie (1965) in the Thomaston quadrangle. Although Fritts does not map such a unit in the Southington, Ansonia, or Milford quadrangles, he does map lenses of marble and amphibolite that we consider to be Russell Mountain along the east side of the Straits Schist in the Mount Carmel quadrangle. The Russell Mountain also appears as lenses of amphibolite along The Straits-Prospect contact west of the Southington Mountain fault in the Naugatuck quadrangle (Carr, 1960). The Russell Mountain is represented in the Long Hill quadrangle by lenses of marble and amphibolite along The Straits-Collinsville contact and in the Bridgeport quadrangle by lenses of quartzite and amphibolite at the corresponding stratigraphic position (Crowley, 1968). The southernmost Russell Mountain that we have recognized is the lenses of marble, amphibolite, quartzite, and calc-silicate rock along The Straits-Fairfield contact in the Westport quadrangle (Dieterich, 1968b). Thus, the Russell Mountain appears to be a significant though discontinuous unit throughout the eastern part of western Connecticut.

The Goshen Formation of Massachusetts is continuous and correlative with the Northfield Formation of southeastern Vermont from which it differs in having more quartzo-feldspathic material. It trends southward across Massachusetts and passes under the

Triassic rocks just north of the Southwick-Woronoco quadrangle boundary. Between the Blandford and Collinsville quadrangles Schnabel (in Hatch and others, 1968) has mapped these rocks as Unit 5 (exclusive of the basal coticule-bearing beds). As shown on plate 1, this area of rock around the Granville and Granby domes, which we interpret as Goshen, is isolated at the present erosion surface from the main mass of Goshen in Massachusetts to the north and from rocks mapped as The Straits Schist, which we now correlate with the Goshen, in the Collinsville quadrangle to the south (Stanley, 1964).

To the southwest in the Torrington quadrangle, the Goshen is mapped as The Straits Schist, except for the northwestern 300 m which we consider to be correlative with the Hawley. In the Thomaston quadrangle, the Goshen is equivalent to The Straits Schist mapped by Cassie (1965) in the northeastern and southern parts of the quadrangle but is not equivalent to the north-central belt. In the Waterbury quadrangle, The Straits Schist and the Southington Mountain Members of the Hartland are predominantly Goshen equivalents.

In the Southington quadrangle (Fritts, 1963a), the Southington Mountain Schist west of the Larsens Pond fault and the Straits Schist exclusive of the area discussed on page 37 around the large amphibolite body are both correlative with the Goshen. In the Mount Carmel quadrangle (Fritts, 1963b), the Straits Schist and the Southington Mountain Schist east of the staurolite isograd are Goshen, whereas the Derby Hill Schist is part of the Wepawaug Schist, which we consider to be an eastern facies of the Straits. In the Ansonia and Milford quadrangle (Fritts, 1965a, b), the Straits Schist and the Southington Mountain Schist just west of the East Derby fault (pl. 1) are Goshen, whereas the Derby Hill Schist north of Long Hill and Coram Hill is part of the Wepawaug Schist.

In the Naugatuck quadrangle, The Straits Schist as mapped by Carr (1960) is Goshen, whereas the Orange Phyllite is the Waits River equivalent, the Wepawaug.

In the Long Hill quadrangle (Crowley, 1968), The Straits Schist, exclusive of the upper member south of the latitude of Trap Falls Reservoir, is Goshen. In the Bridgeport quadrangle (Crowley, 1968), the Goshen is represented by the lower member of The Straits, the Cooks Pond Schist, and the staurolite schist of the Southington Mountain Formation west of the sillimanite isograd.

Finally, the south end of the Goshen-Straits belt is represented by The Straits Schist as mapped by Dietrich (1968a) in the Westport quadrangle. Thus, rocks of Silurian and Devonian age form a remarkably continuous but highly deformed belt across the eastern part of western Connecticut.

STRATIGRAPHIC SECTIONS

The stratigraphic sections discussed in this report are given on the following pages. The nomenclature, lithologic descriptions, stratigraphic order, and geologic ages are taken from the map explanations of the pertinent reports, supplemented by descriptive material in the text of the reports. Because thicknesses are generally not stated in these reports, we calculated the thicknesses given in the following sections from measurements on maps and cross sections in the pertinent reports.

SECTION 1.—*Across the northern part of the Plainfield and adjacent Windsor quadrangles, Massachusetts, at about latitude 42°35'*

[From Osberg, Hatch, and Norton (1971) and Norton (1967)]

Age	Formation	Member or subunit	Description	Thickness (meters)
Middle Silurian to Early Devonian.	Goshen Formation.	--------	Gray crinkly fine- to medium-grained carbonaceous slightly rusty weathered quartz-muscovite schist with porphyroblasts of biotite, chlorite, and garnet. Indistinctly to to well bedded in beds 5–10 cm thick, commonly graded.	450
Middle Ordovician.	Hawley Formation.	Black schist.	Black noncrinkly fine-grained carbonaceous rusty-weathered sulfidic quartz-mica schist and quartzite.	8
		Volcanic unit.	About 40 percent white fine-grained granular feldspar rock with minor quartz, biotite, and chlorite, and 60 percent dark-green medium-grained amphibolite.	30
		Black schist.	Black noncrinkly fine-grained carbonaceous rusty-weathered, sulfidic quartz-mica schist and quartzite.	8
		Volcanic unit.	Interbedded dark-gray-green medium-grained plagioclase-hornblende amphibolite and white, light-gray, or light-brown fine- to medium-grained schistose to granullose feldspar and feldspar-mica schist.	340
		Fragmental volcanic unit.	Medium- to dark-gray plagioclase-hornblende-chlorite schist with conspicuous 2–4 mm plagioclase insets and angular rock fragments.	60
		Volcanic unit.	Dark-green fine- to medium-grained schistose to massive plagioclase (65 percent)-hornblende (25 percent)-(chlorite)-(epidote) amphibolite.	

SECTION 1.—*Across the northern part of the Plainfield and adjacent Windsor quadrangles, Massachusetts, at about latitude 42°35'*—Continued

Age	Formation	Member or subunit	Description	Thickness (meters)
Middle Ordovician—Con.	Hawley Formation—Con.	Fragmental volcanic unit.	Medium- to dark-gray plagioclase (65 percent)-hornblende (25 percent)-chlorite schist with conspicuous 2–4 mm plagioclase insets and angular rock fragments.	250
		Volcanic unit.	Green to dark-green fine- to medium-grained schistose to massive plagioclase (65 percent)-hornblende (25 percent) - (chlorite) - (epidote) amphibolite.	340
		Felsic volcanic unit.	White to light-green plagioclase granulite with minor white to light-gray plagioclase (90 percent)-calcite-chlorite granulite and plagioclase (80 percent) - quartz-hornblende-garnet gneiss.	100
		Volcanic unit.	Green to dark-green fine- to medium-grained schistose to massive plagioclase (65 percent) - hornblende (25 percent) - (chlorite) - (epidote) amphibolite.	400
	Moretown Formation.	Garnet schist.	Approximately equal parts of buff to light-gray fine- to medium-grained quartz-muscovite - plagioclase - biotite schist with distinct 2–5 mm garnet porphyroblasts, light-gray fine-grained pinstriped quartz - plagioclase - biotite granulite, and dark - green medium - grained hornblende-plagioclase amphibolite.	210
		Granulite.	Light-gray to buff fine-grained nonrusty-weathered pinstriped quartz - plagioclase-biotite granulite, locally light-gray quartz-muscovite-biotite schist with contorted beds 2–20 mm thick of fine-grained quartzite, and minor medium-grained dark-green hornblende-plagioclase amphibolite.	2,800
Early to Late Cambrian and Early Ordovician.	Rowe Schist.	Green schist.	Light-green fine-grained nonrusty-weathered quartz-muscovite - chlorite phyllite and schist with minor albite and magnetite, and abundant lenses of granular quartz about 1 by 10 cm.	150
		Amphibolite.	Dark-green medium - grained hornblende - plagioclase amphibolite.	10

SECTION 1.—*Across the northern part of the Plainfield and adjacent Windsor quadrangles, Massachusetts, at about latitude 42°35′*—Continued

Age	Formation	Member or subunit	Description	Thickness (meters)
Early to Late Cambrian and Early Ordovician—Con.	Rowe Schist—Con.	Green schist.	Light-green fine-grained non-rusty-weathered quartz-muscovite-chlorite phyllite and schist with minor albite and magnetite, and abundant lenses of granular quartz 1 by 10 cm.	45
		Amphibolite.	Dark-green medium - grained hornblende - plagioclase amphibolite.	10
		Green schist.	Light-green fine-grained non-rusty-weathered quartz-muscovite-chlorite phyllite and schist with minor albite and magnetite, and abundant lenses of granular quartz about 1 by 10 cm.	300
		Amphibolite.	Dark-green medium - grained hornblende - plagioclase amphibolite.	25
		Green schist.	Light-green fine - grained non-rusty-weathered quartz-muscovite-chlorite phyllite and schist with minor albite and magnetite, and abundant lenses of granular quartz 1 by 10 cm.	210
		Gray schist.	Gray fine- to medium-grained carbonaceous quartz - muscovite and quartz-muscovite-biotite phyllite with scattered garnet porphyroblasts, and minor thin beds of light- to dark-gray fine-grained quartzite.	90
Early Cambrian or older.	Hoosac Formation.	--------	Gray to gray-brown medium-grained rusty-weathered quartz - albite - biotite-muscovite - (garnet) - (chlorite) schist and gneiss commonly with conspicuous 2–5 mm albite megacrysts, generally indistinctly bedded.	900
			Quartz-muscovite-calcite schist texturally similar to above.	30
			Gray to gray-brown medium-grained rusty - weathered quartz-albite - biotite-muscovite - (garnet) - (chlorite) schist and gneiss commonly with conspicuous 2–5 mm albite megacrysts, generally indistinctly bedded.	30
			Muscovite - paragonite - quartz-garnet schist otherwise similar to above unit.	30

SECTION 1.—*Across the northern part of the Plainfield and adjacent Windsor quadrangles, Massachusetts, at about latitude 42°35'*—Continued

Age	Formation	Member or subunit	Description	Thickness (meters)
Early Cambrian or older—Con.	Hoosac Formation—Con.	----------	White to gray quartz-microcline-albite-muscovite gneiss and granulite, locally pebbly near base.	150

SECTION 2.—*Approximately at the boundary of the Chester and Blandford quadrangles, Massachusetts, at about latitude 42°15'*

[From Hatch, Norton, and Clark (1970) and Hatch and Stanley (unpub. data)]

Age	Formation	Member or subunit	Description	Thickness (meters)
Middle Silurian to Early Devonian.	Goshen Formation.	Upper thin bedded unit.	Light- to dark-gray fine- to medium-grained carbonaceous slightly to nonrusty-weathered quartz-muscovite-biotite-garnet-staurolite-kyanite schist and quartz-muscovite-biotite granular schist in graded beds 5–15 cm thick. Minor thin beds of calc-silicate granulite.	150
		Quartzite.	Light-gray to light-gray-brown fine-grained micaceous quartzite and quartz-muscovite-biotite-garnet schist, and massive light-greenish-gray calc-silicate granulite. Beds generally 0.5–6 m thick but commonly show minor internal compositional layering. Crossbedding common.	300
		Lower thin bedded unit.	Light- to dark-gray fine- to medium-grained carbonaceous slightly to nonrusty-weathered quartz-muscovite-biotite-garnet-staurolite-kyanite schist and quartz-muscovite-biotite granular schist in graded beds 5–15 cm thick.	370
Middle Ordovician.	Hawley Formation.	Black schist.	Dark-gray to black carbonaceous sulfidic rusty-weathered splintery-textured quartz-muscovite-biotite-(garnet) schist, light-gray to black fine-grained thinly laminated quartzite, and, locally, thinly laminated pink "coticule" granulite.	45
		Volcanic unit.	Dark-green medium-grained plagioclase-hornblende amphibolite and light-brown plagioclase-biotite schist.	

SECTION 2.—*Approximately at the boundary of the Chester and Blandford quadrangles, Massachusetts, at about latitude 42°15'*—Continued

Age	Formation	Member or subunit	Description	Thickness (meters)
Middle Ordovician—Con.	Hawley Formation—Con.	Black schist.	Dark-gray to black carbonaceous sulfidic rusty-weathered splintery textured quartz-muscovite - biotite-(garnet) schist, light-gray to black fine-grained thinly laminated quartite, and, locally, thinly laminated pink coticule granulite. Scattered intervals of noncarbonaceous brown or light-gray well-bedded (5–10 cm) quartz-muscovite - biotite - garnet schist and granular schist.	450
		Volcanic unit.	Dark-green medium - grained plagioclase - hornblende amphibolite and light - brown plagioclase-biotite schist.	30
		Black schist.	Dark-gray to black carbonaceous sulfidic rusty-weathered splintery textured quartz-muscovite - biotite - (garnet) schist, light-gray to black fine-grained thinly laminated quartzite, and, locally, thinly laminated pink coticule granulite.	300
		Volcanic unit.	Dark-green medium - grained plagioclase - hornblende amphibolite and light - brown plagioclase - biotite schist, with scattered thin beds of fine-grained thinly laminated coticule granulite.	90
	Moretown Formation.	Garnet schist.	Approximately equal parts of light - gray muscovite-quartz - biotite - garnet-chlorite-plagioclase schist with conspicuous 4–5 mm garnet porphyroblasts, light - gray fine-grained pinstriped quartz - plagioclase - biotite granulite, and dark-green fine- to medium - grained plagioclase - hornblende amphibolite.	450
		Granulite.	Light-gray to light-gray-brown fine - grained quartz-plagioclase-biotite - granulite and granular schist with characteristic pinstripe structure. Beds generally 5–25 cm thick. Minor dark-green fine- to medium - grained plagioclase-hornblende amphibolite.	600

SECTION 2.—*Approximately at the boundary of the Chester and Blandford quadrangles, Massachusetts, at about latitude 42°15′*—Continued

Age	Formation	Member or subunit	Description	Thickness (meters)
Early to Late Cambrian and Early Ordovician.	Rowe Schist.	Green schist.	Light-green fine-grained muscovite - quartz-chlorite-(garnet) schist with local conspicuous magnetite or plagioclase and abundant lenses of granular quartz about 1 by 10 cm. Bedding generally absent or inconspicuous.	180
		Amphibolite.	Dark-green medium - grained massive to schistose plagioclase - hornblende amphibolite intruded at upper contact by steatitized serpentinite.	180
		Green schist.	Light-green fine-grained muscovite - quartz-chlorite-(garnet) schist with local conspicuous magnetite or plagioclase and abundant lenses of granular quartz about 1 by 10 cm. Bedding generally absent or indistinct.	120
		Amphibolite.	Dark-green medium - grained schistose plagioclase - hornblende amphibolite.	
		Green schist.	Light-green fine - grained muscovite-quartz - chlorite-(garnet) schist with local conspicuous magnetite or plagioclase and abundant lenses of granular quartz about 1 by 10 cm. Bedding generally absent or indistinct.	110
		Gray schist.	Dark - gray to gray locally rusty-weathered fine-grained quartz-mica schist, gray to brown quartz - biotite granular schist, and light- to dark-gray fine-grained quartzite.	370
Early Cambrian or older.	Hoosac Formation.	--------	Gray to gray-brown medium-grained nonrusty to moderately rusty - weathered quartz - plagioclase - mica gneiss, and quartz - plagioclase-muscovite - biotite-garnet-(staurolite) - (kyanite)-(chlorite) schist. Beds locally 15–25 cm thick, but generally indistinct.	920

SECTION 3.—*Across the Blandford and Woronoco quadrangles, Massachusetts, about 1.3 kilometers south of the village of Blandford, latitude 42°09′*

[Hatch and Stanley, unpub. data]

Age	Formation	Member or subunit	Description	Thickness (meters)
Middle Silurian to Early Devonian.	Goshen Formation.	Quartzite.	Light - gray to light - gray-brown fine - grained micaceous quartzite and quartz-muscovite - biotite - garnet schist, and massive light-greenish-gray calc - silicate granulite. Beds generally 0.5–6 m thick but commonly show minor internal compositional layering. Local crossbedding.	250
		Lower thin-bedded unit.	Light- to dark-gray fine- to medium-grained carbonaceous slightly rusty to nonrusty-weathered quartz-muscovite-biotite - garnet - staurolite - kyanite schist and quartz-muscovite - biotite granular schist in graded beds 5–15 cm thick.	400
Middle Silurian.	Russell Mountain Formation.		Interbedded sequence of calc-silicate granulite and carbonate calc-silicate granulite in beds 15–30 cm thick interlayered in some places with glassy quartzite which is white, very light gray or light brown where fresh and slightly rusty where weathered. Quartz pebbles as much as 2 cm in diameter scattered throughout the quartzite. White quartzite may contain muscovite.	0–30
Middle Ordovician.	Cobble Mountain Formation.	Thick-bedded unit.	Predominantly nonrusty-weathering medium- to coarse - grained feldspathic gneiss and schist with four distinct mappable zones of medium-grained rusty schist with subordinate beds of thin quartz - plagioclase gneiss which vary from 0 to 500 m in thickness. A lens 0–200 m thick of aluminous schist with subordinate rusty and nonrusty schist is mapped in the uppermost rusty zone in the southern 2 km of the Woronoco quadrangle. Amphibolite beds common in the lower part.	0–1,600

SECTION 3.—*Across the Blandford and Woronoco quadrangles, Massachusetts, about 1.3 kilometers south of the village of Blandford, latitude 42°09'*
—Continued

Age	Formation	Member or subunit	Description	Thickness (meters)
Middle Ordovician—Con.	Cobble Mountain Formation—Con.	Thin-bedded unit.	Light-brown thin-bedded fine-grained granulite and gneiss interbedded with light-brown to gray-brown mica-quartz-plagioclase - garnet - staurolite schist. Amphibolite beds common. The lower 200 m is a distinctive red - rusty - weathered quartz - mica - plagioclase-garnet schist with thin beds 5–10 cm thick of white quartz - plagioclase - quartzite. Graphitic zones common. Beds of amphibolite and hornblende-anthophyllite amphibolite present locally.	0–1,500
		Moretown Formation.	Light - gray or light - gray-brown nonrusty - weathered fine-grained pinstriped quartz - plagioclase - biotite-(garnet) - (muscovite) - (chlorite) granulite and granular schist generally well bedded in beds 5–50 cm thick. Coticule locally common.	650
Early to Late Cambrian and Early Ordovician.	Rowe Schist.	Green schist.	Light-gray-green to light-gray fine- to medium-grained indistinctly to nonbedded quartz - muscovite - plagioclase schist with local but conspicuous porphyroblasts of staurolite, kyanite, biotite, garnet, and chlorite. Quartz lenses and lamellae common in kyanite-rich schist.	300
		Amphibolite.	Dark-green fine- to medium-grained nonbedded to poorly bedded slabby - weathered plagioclase - hornblende amphibolite with minor quartz, chlorite, biotite, and ilmenite.	250
		Gray schist.	Gray to gray-brown, slightly rusty weathered, medium-grained carbonaceous quartz-muscovite - plagioclase- biotite - garnet - (staurolite)-(kyanite) schist with local thin beds of black or gray biotitic quartzite.	250
Early Cambrian or older.	Hoosac Formation.	--------	Gray - brown, slightly rusty to nonrusty-weathered, medium-grained indistinctly bedded quartz-plagioclase-biotite gneiss and quartz - plagio-	1,000

SECTION 3.—*Across the Blandford and Woronoco quadrangles, Massachusetts, about 1.3 kilometers south of the village of Blandford, latitude 42°09′* —Continued

Age	Formation	Member or subunit	Description	Thickness (meters)
Early Cambrian—Con.	Hoosac Formation—Con.		clase-muscovite - biotite-garnet-kyanite - staurolite schist with local silvery porphyroblasts of muscovite 2–4 mm in diameter.	
Precambrian.	--------	--------	Light- to medium-gray-brown nonrusty-weathered medium-grained thinly banded microcline-quartz - plagioclase- biotite gneiss.	1,000+

SECTION 4.—*Composite section for the West Granville and Southwick, quadrangles, Massachusetts—Connecticut, and New Hartford quadrangles, Connecticut*

[From Schnabel *in* Hatch, Schnabel, and Norton (1968, p. 182–183)]

Age	Formation	Member or subunit	Description	Thickness (meters)
Middle Ordovician.	Unit 8	-----------	Heterogeneous sequence of schists, gneisses, granulites, and, locally, amphibolites. Soft friable quartz-mica schist common. Coticule common in upper part of unit in southern part of area. Local graded bedding indicates Unit 8 overlies Unit 7.	900+
	Unit 7	-----------	Gray, extremely coarse grained, nonrusty-weathered quartz - plagioclase - muscovite-biotite schist. Megacrysts of garnet, kyanite, and sillimanite particularly abundant in south. Quartz lenses as much as 30 cm long common.	1,200
	Unit 6	-----------	Calc-silicate rock, amphibolite, quartzite, and schist. Overall composition of unit varies widely. Unit thickens to south.	6–600
	Unit 5	-----------	Predominantly gray and brown rusty-weathered slightly carbonaceous quartz-plagioclase-muscovite-biotite schist. In northern part of area lower part of unit contains thin coticule beds; middle part contains abundant lenses of zoisite amphibolite. Locally graded bedded, indicating unit overlies Unit 4.	900
	Unit 4	-----------	Coarse-grained locally garnetiferous amphibolite and felsic gneiss in beds 2.5 cm to 6 m thick with abundant 2–15 cm coticule beds near top of unit.	1,500

SECTION 4.—*Composite section for the West Granville and Southwick quadrangles, Massachusetts—Connecticut, and New Hartford quadrangles, Connecticut*—Continued

Age	Formation	Member or subunit	Description	Thickness (meters)
Middle Ordovician—Con.	Unit 3		Gray fine-grained nonrusty-weathered locally pinstriped quartz - plagioclase - biotite-muscovite granulite and schist. Local lenses of amphibolite and thin beds of coticule. Very thinly laminated.	0–1,500
Early Cambrian to Early Ordovician.	Unit 2		Dark - yellowish - brown to reddish-brown-weathered fine- to medium - grained muscovite-biotite - quartz - plagioclase schist characterized by 3 mm muscovite porphyroblasts. Moderately well bedded.	600–900
Early Cambrian.	Unit 1		Gray fine-grained brown-rusty-weathered quartz-plagioclase-biotite-muscovite schist with scattered beds of calc-silicate rock and quartzite. Local biotite-rich beds contain plagioclase megacrysts as much as 6 mm in diameter. Generally well bedded.	1,800

SECTION 5.—*For the Collinsville quadrangle, Connecticut*

[From Stanley, 1964]

Age	Formation	Member or subunit	Description	Thickness (meters)
Pre-Triasic.	Slashers Ledges Formation.	Rusty schist member.	Rusty - weathering medium - grained muscovite - quartz-biotite - garnet - plagioclase-staurolite - kyanite schist. Lenses of steatite and serpentine near contact with kyanite schist member.	>120
		Kyanite schist member.	Nonrusty - weathering medium-bluish-gray muscovite-quartz-plagioclase - biotite - kyanite-garnet schist with megascopic magnetite. Porphyroblasts of kyanite, garnet, and plagioclase are common. Schistose amphibolite 1.5–4.5 m thick is between beds of plagioclase - quartz - biotite gneiss and plagioclase-mica-quartz - garnet - staurolite schist in the middle of the member.	90–135

SECTION 5.—*For the Collinsville quadrangle, Connecticut*—Continued

Age	Formation	Member or subunit	Description	Thickness (meters)
Pre-Triassic—Con.	Satans Kingdom Formation.	Breezy Hill Member.	Nonrusty - weathering medium-grained medium - gray to grayish - blue quartz - mica-plagioclase - garnet - staurolite schist containing small porphyroblasts of plagioclase.	350–480
		Ratlum Mountain Member.	A mixed assemblage of commonly nonrusty - weathering, medium- to fine - grained light-colored rocks consisting of quartz - plagioclase-muscovite-biotite - garnet schist, quartz - plagioclase - biotite-garnet gneiss or granulite with minor beds of plagioclase - biotite - amphibole gneiss, calc-silicate gneiss, and garnet amphibolite. Anthophyllite - plagioclase gneiss is locally present near amphibolite.	280
	Rattlesnake Hill Formation.	Upper member (carbonaceous schist member, this report).	Rusty-weathering fine- to medium - grained mica - quartz schist interbedded with thinly to thickly bedded mica quartzite and quartz-plagioclase-mica gneiss. Graphite present in some schist. Garnet and kyanite sparce. Pink coticule quartzite present locally in the eastern part of the quadrangle and abundant on Jones and Yellow Mountains in the western part of the quadrangle.	70–350
		Lower member (feldspathic schist member, this report).	Nonrusty - weathering medium - grained light - gray to medium-dark - gray quartz-muscovite - plagioclase - biotite - garnet - kyanite schist which is feldspathic and (or) rusty weathering in places. Kyanite and garnet porphyroblasts abundant locally. Beds of amphibolite. Just west of the contact with The Straits Schist is a zone 0–30 m thick of calc-silicate gneiss, calc - silicate quartzite, and glassy quartzite with a few thin beds of rusty non-graphitic mica - quartz-plagioclase schist.	50–270

SECTION 5.—*For the Collinsville quadrangle, Connecticut*—Continued

Age	Formation	Member or subunit	Description	Thickness (meters)
Pre-Triassic—Con.	The Straits Schist.	--------	Rusty-weathering, medium- to coarse-grained graphitic quartz-mica-plagioclase-garnet-kyanite schist. Graphite forms a distinctive sheen on the schistosity. Beds 2–4 m thick of graphite-mica-quartz gneiss common. Some beds are graded. A few pods of calc-silicate amphibolite.	220–290 (isoclinal syncline hypothesis)
	Collinsville Formation.	Sweetheart Mountain Member.	Nonrusty-weathering medium- to coarse-grained light- to medium-gray quartz-plagioclase-mica-garnet-kyanite schist. Nongraphitic and more feldspar-rich than The Straits Schist. Beds 30–60 cm thick of amphibolite.	50–180
		Bristol Member.	A heterogeneous unit composed of medium-grained plagioclase-quartz-biotite gneiss with some garnet, quartz-plagioclase-mica-garnet gneiss and schist, with subordinate beds of massive amphibolite. A distinctive zone of pink coticule quartzite is present in the upper part of the member. Two-amphibole gneiss rare. A few outcrops of rusty-weathering sulphide-stained schist in the upper part of the member in the northern part of the Bristol dome on Nepaug Reservoir.	120–300 (measured in Bristol dome)
	Taine Mountain Formation.	Whigville Member.	Nonrusty-weathering medium-grained nongraphitic, light-gray pinstriped to layered schist and granulite containing quartz, mica, plagioclase, and garnet with local kyanite.	80–425
		Scranton Mountain Member.	Rusty-weathering nongraphitic medium-grained mica-quartz-plagioclase-garnet schist with subordinate quartz-plagioclase-mica gneiss and a few thin beds of calc-silicate gneiss.	65–330
		Wildcat Member.	Nonrusty-weathering fine- to medium-grained light-gray pinstriped biotite-plagioclase-quartz gneiss with subordinate biotite-plagioclase-muscovite-quartz schist with local kyanite. A few lenses of amphibolite lithically very similar to the Whigville Member.	>350

SECTION 6.—*For the Torrington quadrangle, Connecticut*

[From Martin, 1970]

Age	Formation	Member or subunit	Description	Thickness (meters)
Early Paleo-zoic(?).	Hart-land For-mation.	Unit III	Thinly interlayered, slabby, fine- to medium-grained dark-gray to purple-gray quartz-plagioclase - mica - granulite and silvery muscovite-plagio-clase - quartz - biotite schist. Graphite abundant in granu-lite. Porphyroblasts of bio-tite and kyanite abundant in schist.	1,450–1,700
		Unit II	Medium - grained biotite-mus-covite - plagioclase - quartz schist with abundant coarse porphyroblasts of plagioclase, garnet, staurolite, and kya-nite. Accessory minerals are chlorite, tourmaline, zircon, apatite, sphene, rutile, and magnetite. Some schist non-porphyroblastic. Thin lenses of amphibolite are less com-mon.	1,600–1,900
	The Straits Schist.	(Corre-lative with Unit II).	Rusty-weathering medium- to coarse - grained plagioclase-mica-quartz schist with porphyroblasts of staurolite, garnet, and kyanite, silvery-gray on fresh surfaces. Ac-cessory minerals are zircon, sphene, apatite, and opaque minerals. Scattered outcrops along the northwestern side of The Straits Schist belt are finer grained, apparently lack kyanite, and contain abundant layers of fine-grained, light - gray biotite-plagioclase - quartz granulite averaging about 2½ cm in thickness.	375
	Hart-land For-mation.	Unit I	Fine - grained gray quartz-plagioclase - mica granulite or granulite gneiss with sub-ordinate layers of mica-plagioclase-quartz schist. In granulitic gneiss micas are concentrated in streaks or pin-stripe layers. Contains a mappable belt of fine- to medium-grained kyanite-mica - plagioclase - quartz granulitic gneiss with sub-ordinate garnet, staurolite, and magnetite.	2,100–2,250

SECTION 6.—*For the Torrington quadrangle, Connecticut*—Continued

Age	Formation	Member or subunit	Description	Thickness (meters)
Early Paleozoic(?).—Con.	Waramaug Formation.	--------	Rusty-weathering quartz-plagioclase-mica gneiss and biotite-quartz-plagioclase-muscovite-kyanite-sillimanite gneiss, interlayered and intermixed. The rock is poorly foliated and has nubby-weathered surfaces where kyanite and sillimanite are present. Lenses of amphibolite present.	2,800–3,600

SECTION 7.—*From the Waterbury quadrangle, Connecticut*

[From Gates and Martin (1967)]

Age	Formation	Member or subunit	Description	Thickness (meters)
Early Paleozoic(?).	Hartland Formation.	Southington Mountain Member.	Medium-grained biotite-muscovite-plagioclase-quartz schist, locally containing kyanite, staurolite, and graphite, generally interlayered with fine-grained biotite-muscovite-plagioclase granulite which distinguishes it from The Straits Schist Member. Also distinguished from Straits by finer grain size, finer powdery rather than spangled muscovite, and sparser and smaller kyanite and garnet. Quartz pods and pegmatite sills and dikes common.	200+
		The Straits Schist Member.	Silvery gray medium- to coarse-grained rusty-weathered oligoclase-biotite-muscovite-quartz schist with porphyroblasts of garnet and kyanite and locally staurolite. Minor chlorite, graphite and magnetite nearly ubiquitous. Discontinuous thin layers of mica-quartz-plagioclase granulite. Lens-shaped pods a few centimeters to a few meters long of white quartz and quartz-feldspar common.	200
		Hitchcock Lake Member.	Thin to thick interlayered finely streaked oligoclase-quartz granulites and coarsely streaked mica-oligoclase-quartz gneiss. Subordinate layers of a friable mica-plagioclase-quartz granulite.	150

SECTION 7.—*From the Waterbury quadrangle, Connecticut,* Continued

Age	Formation	Member or subunit	Description	Thickness (meters)
Early Paleozoic(?)—Con.	Hartland Formation—Con.	Hitchcock Lake Member.—Con.	Distinguished from the Straits by abundant biotite, lack of kyanite, and increase in total quartz-plagioclase. Amphibolitic rocks interlayered with the granulites and gneisses typically at contact with The Straits.	
		Hartland Unit I Member.	Light-gray fine - grained muscovite - biotite - plagioclase-quartz granulite or granulitic gneiss. Subordinate layers of mica - plagioclase - quartz schist present throughout. Local kyanite-bearing mica - plagioclase-quartz granulite and granulitic gneiss. Rare calc-silicate layers.	800+
Precambrian(?)	Waterbury Formation.	--------	Mainly thin to thick interlayered assemblage of light- to dark-gray fine-to medium-grained paragneiss composed of muscovite, biotite, oligoclase to andesine and quartz with minor but ubiquitous kyanite. Mica-rich and mica-poor layers. Kyanite and garnet typically associated with micas. Migmatitic mixtures of the paragneisses and quartzofeldspathic material ranging in composition from trondhjemitic to granitic predominate. Calc-silicate pods are common.	1,000+

SECTION 8.—*From the Southington, Mount Carmel, Ansonia, and Milford quadrangles, Connecticut*

[From Fritts (1962, 1963a, b, 1965a, b)]

Age	Formation	Member or subunit	Description	Thickness (meters)
Silurian and Devonian.	Wepawaug Schist.	---------	Interlayered gray to dark-gray phyllitic schist and quart-rich paragneiss above garnet isograd. Below garnet isograd is less distinctly banded carbonaceous quartz-muscovite-chlorite-albite phyllite. Garnet, biotite, staurolite and kyanite form porphyroblasts in pelitic beds in appropriate metamorphic zones. Local beds and zones of gray medium-grained clinozoisite am-	2,200

SECTION 8.—*From the Southington, Mount Carmel, Ansonia, and Milford quadrangles, Connecticut*—Continued

Age	Formation	Member or subunit	Description	Thickness (meters)
Silurian and Devonian—Con.	Wepawaug Schist—Con.		phibolite, gray coarse-grained quartz-zoisite-hornblende-garnet calc-silicate rock, and impure crystalline marble. Beds of impure crystalline marble as much as 25 m thick most common in upper part of unit.	
Ordovician(?)	Maltby Lakes Volcanics.	Undivided.	Greenish-gray medium- to fine-grained plagioclase-chlorite-actinolitic hornblende-epidote-quartz greenschist and amphibolite. In higher metamorphic grades is dark-gray hornblende-andesine-quartz amphibolite. Lenses of fine-grained greenish-gray phyllitic schist similar to Derby Hill Schist most common in lower part of unit.	600
	--	Pyroclastic member.	Pyroclastic schist with ellipsoidal metabasalt fragments as much as 12 cm long in a matrix of greenish-gray plagioclase-quartz-muscovite-chlorite schist.	125
	Derby Hill Schist.	--------	Greenish-gray to dark-gray medium- to fine-grained thinly laminated quartz-muscovite-chlorite-plagioclase schist. Alternate quartz-rich and muscovite-rich laminae generally less than 5 mm thick. Minor bands of quartz-rich paragneiss as much as 30 cm thick similar to rock of Oronoque Member.	160–1,300
		Oronoque Member.	Greenish-gray to dark-gray medium- to fine-grained slabby to thinly laminated quartz-rich and albite-rich paragneiss with muscovite- and chlorite-rich schistose partings and layers. Local garnet and biotite. Lower part of unit contains mappable lenses of gray fine-grained limestone and dark-gray to black medium-grained hornblende-andesine-quartz-epidote amphibolite similar to amphibolites in Maltby Lake Volcanics, and containing abundant quartz-epidote knots and lenses as much as 3 cm long.	0–1,600

SECTION 8.—*From the Southington, Mount Carmel, Ansonia, and Milford quadrangles, Connecticut*—Continued

Age	Formation	Member or subunit	Description	Thickness (meters)
Cambrian(?) and Ordovician(?)	Southington Mountain Schist.	--------	Mainly interbanded gray medium-grained quartz-plagioclase-biotite-muscovite-garnet-(staurolite)-(kyanite) paragneiss and silvery-gray medium- to fine-grained carbonaceous quartz-muscovite-biotite-oligoclase-garnet-(staurolite)-(kyanite) schist. Minor impure marble and calc-silicate rocks. Includes mappable zones in which quartz-rich paragneiss is greatly predominant over mica schist. Includes mapped thin lenses of greenish-gray to black medium- to fine-grained hornblende-andesine-quartz-clinozoisite amphibolite, greenish-gray to olive-gray medium-grained chlorite-biotite schist characterized by 2–10 cm aggregates of quartz, plagioclase, and tremolite, and greenish-gray to yellow-green medium-grained impure calcite marble.	160–1,600
Cambrian(?)	Straits Schist.	--------	Silvery-gray coarse- to medium-grained carbonaceous quartz-muscovite-biotite-oligoclase-(garnet)-(staurolite) schist. Local lenses of medium-grained chloritic schist composed of quartz, oligoclase, chlorite, biotite, staurolite, and muscovite, dark-greenish-gray hornblende-andesine-(clinozoisite) amphibolite, and white to grayish-orange-pink impure marble.	160–1,600
Precambrian(?)	Waterbury Gneiss.	Hitchcock Lake Member.	Medium- to coarse-grained feldspathic quartz-muscovite-oligoclase-biotite-garnet schist; local paragneiss, and minor calc-silicate rock. Biotite more abundant and individual flakes more conspicuous than in Straits or Southington Mountain Schists. Garnets to 5 cm in diameter. Local small lenses of black hornblende-andesine-quartz amphibolite and garnetiferous amphibolite.	100–300

SECTION 8.—*From the Southington, Mount Carmel, Ansonia, and Milford quadrangles, Connecticut*—Continued

Age	Formation	Member or subunit	Description	Thickness (meters)
Pre-cambrian(?)—Con.	Waterbury Gneiss.—Con.	Paragneiss member.	Light- to dark-gray quartz-biotite-muscovite - oligoclase-kyanite - garnet paragneiss. Minor schist similar to schist in Hitchcock Lake Member and minor calc-silicate rock. Local small lenses of black hornblende-andesine - quartz amphibolite and garnetiferous amphibolite.	300–600

SECTION 9.—*From the the Naugatuck quadrangle, Connecticut*

[From Carr, 1960]

Age	Formation	Member or subunit	Description	Thickness (meters)
Pre-Triassic.	Orange Phyllite.	--------	Homogeneous sequence of fine-grained, blue-gray garnetiferous phyllites consisting primarily of quartz, muscovite and chlorite with minor garnet and plagioclase and local biotite.	1,600+
	Hartland Formation.	Quartzitic member.	A uniform sequence of well-foliated or gneissic muscovite - biotite quartzites. Micas have a sub - parallel orientation set in a granoblastic matrix of quartz and minor plagioclase. Minor chlorite near boundary with Orange Phyllite is always associated with biotite. Minor garnet. At least one 3–6 m band of amphibolite.	300
		Undifferentiated Hartland.	Heterogeneous series of schists, gneisses, quartzites, and amphibolites interbanded with Ansonia Granite, Prospect-like gneiss, pegmatite, and dolerite. Gneisses generally consist of bands a few cm thick of quartz and plagioclase (no potassium feldspar) forming a granoblastic matrix for subparallel biotite and muscovite and minor garnet; minor bands of garnetiferous schist. Schists are predominantly 2 mica-garnet schists without staurolite or kyanite. Calcite marble, diopside - tremolite schist, and hornblende schist are present locally. Mappable band of amphibolite present locally at base of unit.	2,000(?)

SECTION 9.—*From the Naugatuck quadrangle, Connecticut*—Continued

Age	Formation	Member or subunit	Description	Thickness (meters)
Pre-Triassic—Con.	Hartland Formation—Con.	The Straits Schist Member.	Coarse to very coarse, flaky, brown - weathering biotite-bearing muscovite schist, generally interbanded with quartz veins. Garnet and kyanite common. Mineral percentages are: quartz 35–65, plagioclase 10–15, muscovite 17–24, biotite 12–15, garnet 3–5.	800
	Waterbury Gneiss.	--------	Predominantly light-gray medium- to fine - grained mica-quartz gneiss or mica quartzite containing 10–20 percent micas which locally grade into less micaceous microcline - plagioclase- quartz gneiss. Locally present are biotite- (garnet) schist, fine-grained, greenish - gray brown - weathered diopside-microcline rock, and light-gray microcline-quartz-oligoclase-biotite gneiss, formerly mapped by Rice and Gregory (1906) as Thomaston Granite.	2,000+

SECTION 10.—*Compiled for the Long Hill and Bridgeport quadrangles, Connecticut*

[From Crowley, 1968]

Age	Formation	Member or subunit	Description	Thickness (meters)
Middle and Late Ordovician(?).	Prospect Formation.	Calcareous member.	Thinly to thickly bedded, rusty - weathering, punky biotite schist; coarse-grained graphitic quartz - muscovite-biotite schist; medium-grained felsic biotite gneiss; pyritiferous calc - silicate quartz rock, and thin bands of impure calcite marble.	200–215
		Golden Hill Schist Member.	Medium- to coarse - grained quartz - muscovite - biotite-plagioclase - garnet schist with subordinate interlayered fine- to medium-grained quartz - plagioclase-biotite - muscovite - garnet gneiss and quartzite.	1,000
		Beardsley Gneiss Member.	Strongly lineated, medium-grained plagioclase - microcline-quartz - hornblende-biotite-epidote gneiss, generally bearing large Carlsbad-twinned megacrysts of micro-	240–500

SECTION 10.—*Compiled for the Long Hill and Bridgeport quadrangles, Connecticut*—Continued

Age	Formation	Member or subunit	Description	Thickness (meters)
Middle and Late Ordovician (?)—Con.	Prospect Formation—Con.	Beardsley Gneiss Member.—Con.	cline; acompanied throughout by pods and lenses much richer in hornblende. Clots and veins of pink pegmatite and epidote-rich pods are characteristic.	
		Pumpkin Ground Member.	Mostly typically moderately well foliated medium-grained. plagioclase-microcline-quartz biotite gneiss bearing numerous large, euhedral megacrysts of Carlsbad-twinned microcline, with minor interlayered muscovitic and biotitic schist, feldspathic and quartzose biotite gneiss, feldspar-quartz-muscovite-garnet gneiss and micaceous quartzite.	270–480
	Southington Mountain Formation.	Banded schist member	Thinly interlayered, medium-to coarse-grained quartz-muscovite-biotite-plagioclase-garnet schist and finer grained quartzose and feldspathic biotite gneiss.	80–900
		Biotite gneiss member.	Medium- to coarse-grained feldspathic biotite gneiss typically containing a small amount of garnet and hornblende and characterized by plagioclase augen. The content of mafic minerals is variable and defines a layering in which mafic-poor and mafic-rich layers alternate.	0–200
		Staurolite schist member.	Uniform rusty-weathering medium- to coarse-grained graphitic quartz-muscovite-biotite-plagioclase garnet schist bearing large sericitized porphyroblasts of staurolite and kyanite.	200
	Trap Falls Formation.	North western facies.	Largely medium- to coarse-grained quartz-muscovite-biotite-garnet schist and finely laminated, fine-grained quartz-muscovite-biotite schist weathering deep rusty red. Includes interlayered feldspathic gneiss, some of which resembles the chief rock type of the Shelton facies.	1,400
		Shelton facies.	Largely medium-grained, generally poorly foliated	300–450

SECTION 10.—*Compiled for the Long Hill and Bridgeport quadrangles, Connecticut*—Continued

Age	Formation	Member or subunit	Description	Thickness (meters)
Middle and late Ordovician (?) —Con.	Trap Falls Formation. —Con.	Shelton facies. —Con.	plagioclase - quartz - microcline-muscovite-garnet gneiss weathering very light tan and bearing tiny spheroidal garnets less than 1 mm in diameter. Mapped as Ansonia Gneiss in Ansonia quadrangle (Fritts, 1965a). Interlayered metasediments include medium- to coarse-grained biotitic and muscovitic schist, fine- to medium-grained quartz - plagioclase-biotite gneiss, and tough fine - grained calc - silicate rock. Contains separately mappable bodies of metasediment composed largely of rusty-weathering coarse-grained muscovite - garnet-plagioclase - quartz - biotite-tourmaline schist with garnet porphyroblasts, interlayered with thin layers of finer grained quartz - plagioclase-biotite gneiss, fine- to medium-grained biotitic and muscovitic schist and feldspar-quartz - mica gneiss. Includes minor amphibolite, hornblende-garnet-plagioclase quartzite, and garnet-quartz rock (codicule). Metasedimentary rocks mapped as Southington Mountain Schist in the Ansonia quadrangle (Fritts, 1965a).	
	The Straits Schist.	Upper member.	Coarse-grained locally kyanite-bearing quartz - muscovite-plagioclase - biotite - garnet schist with abundant interlayered biotitic schist and feldspathic schist and gneiss. Amphibolite and (or) quartzite common at the base. Schist is similar to the schist in lower member.	275–320
		Lower member.	Uniform medium- to coarse-grained rusty - weathering quartz - muscovite - biotite-plagioclase - garnet schist, normally graphitic and ordinarily bearing kyanite or sillimanite or both.	200–300

SECTION 10.—*Compiled for the Long Hill and Bridgeport quadrangles, Connecticut*—Continued

Age	Formation	Member or subunit	Description	Thickness (meters)
Middle and Late Ordovician (?) —Con.	Cooks Pond Schist (correlative with The Straits Schist).	----------	Uniform fine-grained rusty-weathering quartz-muscovite-biotite schist with a distinctive sheen due to the presence of abundant fine-grained graphite interleaved with mica.	320
	Collinsville Formation.	--------	Crudely laminated, medium- to coarse-grained feldspathic biotite gneiss locally bearing microcline augen. Finer grained mica-garnet schist and calc-silicate gneiss are locally important. Toward the top includes interlayered amphibolite, quartzite, calcite marble, schist, massive pegmatite and, locally, sulfide deposits.	960
	Newtown Gneiss.	--------	Chiefly medium-grained, poorly foliated to massive feldspar-quartz-biotite gneiss with a variable content of euhedral, large, Carlsbad - twinned microcline megacrysts. Associated minor metasediments include fine-grained, generally finely laminated quartz - plagioclase - biotite - garnet gneiss and fine- and medium-grained mica schist and gneiss locally bearing kyanite and (or) sillimanite. Grades into Collinsville Formation by a decline in megacryst density and an improved definition of foliation.	Undeterminable
	Orange Formation.	Derby Hill Member.	Thin-bedded fine- to medium grained "pinstriped" muscovitic schist and gneiss with interlayered medium- to coarse - grained muscovite-quartz-plagioclase - chlorite-biotite-garnet schist.	1,700
		Oronoque Member.	Similar to Derby Hill Member but includes minor interlayered dark-greenish - black fine- to medium - grained magnetite - rich quartzose amphibolite.	960

SECTION 11.—*For the New Haven-Naugatuck-Westport area, Connecticut*

[Proposed by Dieterich (1968a, p. 3]

Age	Formation	Member or subunit	Description	Thickness (meters)
Paleozoic.	Wepawaug Formation.	---------	Dark-gray graphitic phyllite or phyllitic schist. See Fritts 1965, a, b).	See stratigraphic section 8.
	Maltby Lakes Volcanics.	---------	Mainly intermediate to basic metavolcanic rocks with interlayered metasediments.	Do.
	Allingtown Formation.	--------	Dark massive greenstone interlayered with schist. Fritts (1965a, b) considered this formation to be intrusive into the Derby Hill Formation. Burger (1967) believes this formation to be volcanics interlayered with the upper portions of Fritts' Derby Hill Schist.	Do.
	Derby Hill Formation.	Oronoque Member.	Thinly laminated quartz - rich paragneiss. In part interlayered with Allingtown Formation.	Do.
		Lower member.	Thinly laminated muscovite-chlorite phyllite or schist with quartz - rich paragneiss.	Do.
	The Straits Schist	---------	A distinctive coarse quartzose muscovite schist. It is usually graphitic and commonly contains biotite, garnet, sillimanite, and (or) kyanite.	
	Fairfield Formation.	Upper member.	Interlayered biotite - muscovite schist, biotite gneiss and quartzite with lenses of amphibolite, calc - silicate gneiss, marble, and massive quartzite.	65–130
		Lower member.	Layered muscovite - biotite schist and biotite gneiss.	
	Prospect Formation.	Upper member.	Porphyroblastic and nonporphyroblastic gneiss, hornblende gneiss, and muscovite-biotite schist.	
		Golden Hill Member.	Layered muscovite - biotite schist, biotite gneiss with amphibolite, quartz - oligoclase gneiss and calc - silicate gneiss.	

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