Taconic Stratigraphic Names: Definitions and Synonymies

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By E-AN ZEN

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TACONIC STRATIGRAPHIC NAMES: DEFINITIONS AND SYNONYMIES

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ABSTRACT

The study of the stratigraphy of the Taconic sequence in western New England and eastern New York is hampered by problems of nomenclature. During the course of years, geologists have proposed many stratigraphic names for various rock units in different parts of the Taconic region. Although most of these names refer to lithostratigraphic units, some refer to biostratigraphic units. A number of names have, by definition or by usuage, gradually acquired chronostratigraphic significance. The precise meaning of yet other names has never been clearly defined.

Intensive fieldwork in the Taconic region, especially since 1950, has resulted in a proliferation of new names and of modifications of old names to new acceptations. On the one hand, a particular name may be used by the same worker or different workers for subtly or obviously different rock units; on the other hand, different names may be applied to the same rock unit by different workers. To aid field investigators to traverse this nomenclatorial labyrinth, published stratigraphic names that are currently useful or have been recently used in Taconic geology are compiled in this study. A synonymy is prepared for each name. Each synonymy, as a rule, includes only names that have been used for the same lithostratigraphic unit in geologically contiguous regions. For areas that are not contiguous, rock units and their names are compared and discussed in the text, but no synonymies are produced because of the risk of serious mistakes.

The distinction between lithostratigraphic units and chronostratigraphic units is important for Taconic geology because of the possibility of significant lateral facies transitions within the stratigraphic section. In this study, the term "correlation" is reserved for comparison of time units; for comparison of lithic units the term "equivalence" is used.

INTRODUCTION

The study of Taconic geology began in the early 19th century, when the science of geology was in its infancy in this country. From the beginning, this study has been wrapped in enthusiastic controversies. The inception of the latest major phase of Taconic research was the publication, in 1899, of T. N. Dale's detailed geologic report on the "slate belt" of Vermont and New York. In 1909 Rudolph Ruedemann published his hypothesis that the argillites of the Taconic sequence were deposited in a different trough from the synchronous carbonates that surround it today, and that their present juxta-

position is due to large-scale thrusting. A period of intensive fieldwork followed in the twenties and early thirties; in addition to Ruedemann, A. C. Swinnerton, Arthur Keith, L. M. Prindle, and E. B. Knopf were important contributors. New stratigraphic names multiplied.

A second epoch of intensive work on Taconic geology began about 1950 and still continues. Aided by the availability of superior topographic maps at large scales and of aerial photographs, as well as by a better overall knowledge of geologic relations in New England and in New York, workers have been doing much detailed mapping in the area. One byproduct of these activities is the proliferation of new stratigraphic names, because many workers, realizing the dangers of long-distance lithostratigraphic equation, preferred to establish local names. At the same time, meanings of the older, established names were scrutinized or altered as new stratigraphic information bearing on them was discovered. Although the renewed mapping activities have by no means solved the structural problem of the existence, extent, and nature of the Taconic allochthone, enough data are now extant, especially for the western foothills of the area, to make detailed stratigraphic comparisons feasible.

The present study is an outgrowth of this modern phase of mapping in the Taconic region. One might question the wisdom of compiling a synonymy during a period when new names are being introduced, and when the overall geologic interpretation remains in a state of flux. A compilation of names today would be out of date tomorrow. The Taconic geologist is faced, however, not only with an exceedingly difficult field problem, but also with a maze of names: different names that have subtle differences in definition are applied to the same unit; or the same name, that has more or less different, and perhaps mutually incompatible, acceptations and ramifying implications is applied to several units. This compilation, then, aims at helping the field geologist through the nomenclatorial labyrinth. Although the work is not exhaustive in scope, most of the currently used names have been included. Where elements of interpretation enter, these are discussed in the "Remarks" sections. The compilation is brought up to date as of November 1962.

The stratigraphic nomenclature and age designations used in this report are those of various authors and do not necessarily follow the usage of the U.S. Geological Survey.

ACKNOWLEDGMENT

A work of compilation owes much to the geologists whose field studies furnish indispensable data. During the past 10 years I have

had the good fortune to study the stratigraphy of the Taconic belt and the adjacent rock units in several areas in the company of geologists who have done the real work. These people have freely discussed with me problems of stratigraphic correlation and comparison; upon these discussions I have drawn heavily for the present compilation. I therefore owe these geologists a particular debt of gratitude. Although I alone am responsible for any mistake in this study, the following people should fully share any credit: William B. N. Berry, John M. Bird, Philip H. Hewitt, Lucian B. Platt, Donald B. Potter, Robert C. Shumaker, Thomas W. Talmadge, George Theokritoff, James B. Thompson, Jr., and A. Scott Warthin, Jr.

The manuscript was reviewed by W. B. N. Berry, W. M. Cady, G. V. Cohee, John Rodgers, and George Theokritoff. The many suggestions that these people made for the improvement of the text, both in substance and in presentation, have been most helpful. These people, too, should share any credit that the work might deserve.

CRITERIA FOR SELECTION AND EXCLUSION OF NAMES

Obsolescence.—Formal stratigraphic names proposed before 1880 are few in number. Most of these early names have been excluded from this compilation, because they are by now of mere historical interest, even though some of these names had been current and were used in works that are included here. Date of proposal, however, was not the decisive criterion; some names, though ancient, have been referred to in a nonhistorical context in recent literature, for example, the Salisbury Schist and the Stuyvesant Conglomerate; these names are included. Names such as the Hudson River Beds are included in the appropriate synonymies but are not separately listed. Yet other names, such as the Georgia Slate, are left out altogether.

Some of the early names are lithic but are vaguely defined, for instance, the Talcose Schist and the Hydromica Slate. These names were thought to possess definite stratigraphic significance and therefore were used as such in early correlations. These names are not included here. Other categories of designation, for instance the letter-designations of Dale (1904) for his Rensselaer County sequence, have not been listed as such in the compilation, although they are in the synonymies.

Geologic location of the rock unit.—By and large, this study includes only names of those rock units that are part of the Taconic sequence. By Taconic sequence is meant a broad, informal, nonspecific group of stratigraphic units, intimately related in their space-time succession, and belonging to the shale-graywacke association,

with only minor components of carbonates and orthoquartzites and are virtually free of volcanic material. These rocks either are known to be Cambrian or Ordovician or have been so interpreted. They occupy a limited and fairly well defined geographical area, extending from near Sudbury, Vt., continuously to near the south boundary of Dutchess County, N.Y. All these rocks, at one time or another, have been interpreted as part of a vast thrust sheet, the Taconic allochthone, and are thought to have traveled as coherent units for long distances.

The names of all stratigraphic units that have their type localities within the "allochthonous" Taconic sequence have been included, subject to other qualifications mentioned herein. In addition, modern workers generally concur that, immediately surrounding the controversial Taconic allochthone, there is a nearly continuous belt of Middle-Ordovician gray to black argillite. Lithically, these argillite beds are distinct from the underlying known autochthonous rocks; however, they may closely resemble rocks of the superjacent allochthone, or even be indistinguishable therefrom. Any acceptable theory concerning the geologic evolution of the Taconic rocks must take into account these autochthonous argillites and give a self-consistent interpretation of their space-time relations to the possibly allochthonous Taconic rocks. For this reason, the Middle-Ordovician argillites have been included in this compendium.

Patches of anomalous rocks, dominantly limestone and dolostone, are present within or adjacent to the Taconic sequence. In Vermont these patches occur in the town of Ira (Fowler, 1950; Zen, 1961); Tinmouth (Dale, 1912; Gordon, 1924); and Pawlet (Shumaker, 1960; Billings and others, 1952); in New York they occur in Nassau (Dale, 1892; Ruedemann, 1930; Balk, 1963); Greenwich (Ruedemann, *in* Cushing and Ruedemann, 1914); Ghent (Craddock, 1957) and Chatham (Craddock, 1957; Talmadge, 1956). These rocks are lithically indistinquishable from parts of the surrounding autochthonous Ordovician carbonate sequence, and such fossils as exist support the identification. Two of these patches have received local names: the Tackawasick Limestone and the Bald Mountain Limestone. Because the interpretation of these limestones is part of the Taconic problem, the names are included.

Stratigraphic units, such as the Austin Glen Graywacke and the Rowe Schist, have their type localities and significant parts of outcrop areas outside of the Taconic belt, but the names have entered the Taconic vocabulary through correspondence of lithic units within the Taconic sequence. These names are included.

Nature of the reference material.—The American Commission on Stratigraphic Nomenclature (1961, p. 653) defines acceptable publica-

tion for new stratigraphic names. Guidebooks for field trips are not considered by the commission as satisfactory sources. The fact remains, however, that new names have appeared in guidebooks, and have been adopted for fieldwork. For some important units, guidebooks are the only published source of widely used names: A good example is the name Hatch Hill Formation of Theokritoff, which first appeared in the 1959 guidebook for the New England Intercollegiate Geological Conference and, to 1962, has not been described formally. Names that first appeared in guidebooks, therefore, have been included in this compilation.

New stratigraphic names that have been published only in abstracts in programs for meetings are fortunately few in number. For reasons of usefulness, they have been included in the synonymy, but they are not separately listed.

Many stratigraphic names for the Taconic region have been proposed or modified in theses from various universities but have not been published elsewhere. Recent examples of such stratigraphic names are found in the works of Theokritoff (1960), Shumaker (1960), Platt (1960), Elam (1960), Talmadge (1956), O'Brien (1960), and Bird (1962). These stratigraphic names have all been excluded unless also published elsewhere. An exception is made for the thesis of A. C. Swinnerton (1922); Swinnerton did much of the fundamental stratigraphic work later published and discussed by Keith (1932). The thesis is unlikely to be published; the significance of Swinnerton's work, however, merits its inclusion here. As a matter of fact, such names as the Bull Slate and the Hooker Slate, first proposed by Swinnerton, still remain important in modern nomenclature.

COMMENTS ON THE FORMAT

Name.—For the sake of uniformity, the format adopted for all statigraphic names follows that recommended by the American Commission on Stratigraphic Nomenclature (1961), even though such a format may differ from the original usage of the authors.

Without exception, only stratigraphic names after geographic places are listed. Names designated by letters or by the petrographic characteristics, even where thought to be stratigraphically significant, are not included. Rock units that primarily indicate gross lithological types without regard to their relative stratigraphic positions and that are based on theoretical arguments of the sedimentary environments, such as the Eddy Hill Lithofacies, the Mettawee Lithofacies, the Schodack Lithofacies, and the Diamond Rock Lithofacies (Lochman, 1956, p. 1336–1339), are not included.

A few names have been spelled in different ways and also given different designations (such as formation, group, shale, slate, beds) without stated differences in acceptation; notable examples of these are the Deepkill and the Normanskill. While these differences are trivial, other ostensibly analogous differences (for instance, the Schodack Shale and Limestone as opposed to the Schodack Formation) may denote entirely different rock groups; hence clarification of each variant is necessary. For the trivial variants, the spellings and designations in the correlation charts for the Cambrian System (Howell and others, 1944) and for the Ordovician System (Twenhofel and others, 1954) have been accepted as the norm and the variants have been included in the synonymy.

Reference.—Except as noted above, and subject to the restrictions on the admissibility of the source material discussed previously, the reference that immediately follows the name of the stratigraphic unit gives the first citation in the literature of the name and its hierarchical rank, insofar as this first citation could be traced. One exception is the "Snake Hill Shale." Ulrich first published the name in 1911 without comment, but the formal introduction of the name was by Ruedemann (1912). Ruedemann's work is accepted here as the source. A few names, notably the Salisbury Schist and the Stuyvesant Conglomerate, were introduced informally to refer to outcrops in these particular places and were not intended as formal names. These names, nevertheless, have become accepted through usage, and their original informal usage is quoted as the source.

Synonymy.—Two principal categories of names are included in the synonymy. To the first category belong the spelling variants and trivial changes in rock designation, such as "beds," "shale," "slate." This group is small, and has been included largely for completeness. Although a fairly careful search of the literature has been made, the lists are not exhaustive.

The second category concerns different names for the same rock unit and forms the bulk of the synonymy. In compiling this synonymy, elements of correlation and judgment necessarily must enter, especially where the type localities are far apart. Even if the rocks of the several type localities demonstrably belong to the same mappable unit, different geologic maps of the same general region may show parts of the area as belonging to different formations. Thus, geologist *A* might call two successive formations the Bull and the Hooker; geologist *B*, mapping the same area, might call these the Mettawee and the Schodack. The Bull and the Mettawee may be the same rock unit, but for some reason part of the Mettawee of geologist *B* was intentionally mapped as the Hooker by geologist *A*.

Do the Hooker and the Mettawee, then, constitute synonyms? The writer has tried to indicate such situations of nomenclatorial overlap by the qualifying words "in part" after the citation of the name.

Another problem is the areal extent to which the synonymy ought to apply. Puristically, a synonymy would apply only to the type locality of the rock unit in question. However, such a system would not be helpful to the field geologist, because he is interested in the rocks between type localities as well. Moreover, this procedure is logically impossible because even such a strict synonymy involves equating two spatially separated outcrops.

The other extreme position would be to produce a synonymy for the entire Taconic region, which under each name would list all the other names that have been proposed for the same rock in its various lithologic aspects and in different parts of the region. This procedure is unfeasible, because a number of published usages of stratigraphic names are now known to be untenable and thus of no practical interest. Moreover, for many important rock units, such a synonymy would include a large part of the entire gamut of names. Finally, the equivalence of many rock units and names, especially from widely separated parts of the Taconic region, cannot as yet be established; some may never be. A synonymy that uncritically includes all these names would not be very useful.

The adopted synonymy attempts to pursue a middle course by listing the names of those rock units whose type localities are in geologically contiguous areas, and are correlative or equivalent with the principal rock unit concerned. For this purpose, the terms "northern Taconic region," "central Taconic region," and "southern Taconic region" have occasionally been used; however, for obvious reasons their boundaries are not defined. Each synonymy, thus, lists names of rocks whose complete or partial equivalences are fairly reliable, through continuity on the ground between type sections, through detailed stratigraphic comparison, or through the original definition of the names (for example, the Nassau Beds were defined by Ruedemann (in Cushing and Ruedemann, 1914) to be Units A–E of Dale's Rensselaer County succession). Points that require discussion, as well as long-distance correlations, are included under the "Remarks" sections.

Type locality.—Whenever feasible, the original type localities are identified. The town name is given if possible, and the most up-to-date U.S. Geological Survey topographic sheet that shows the type locality is cited (fig. 1).

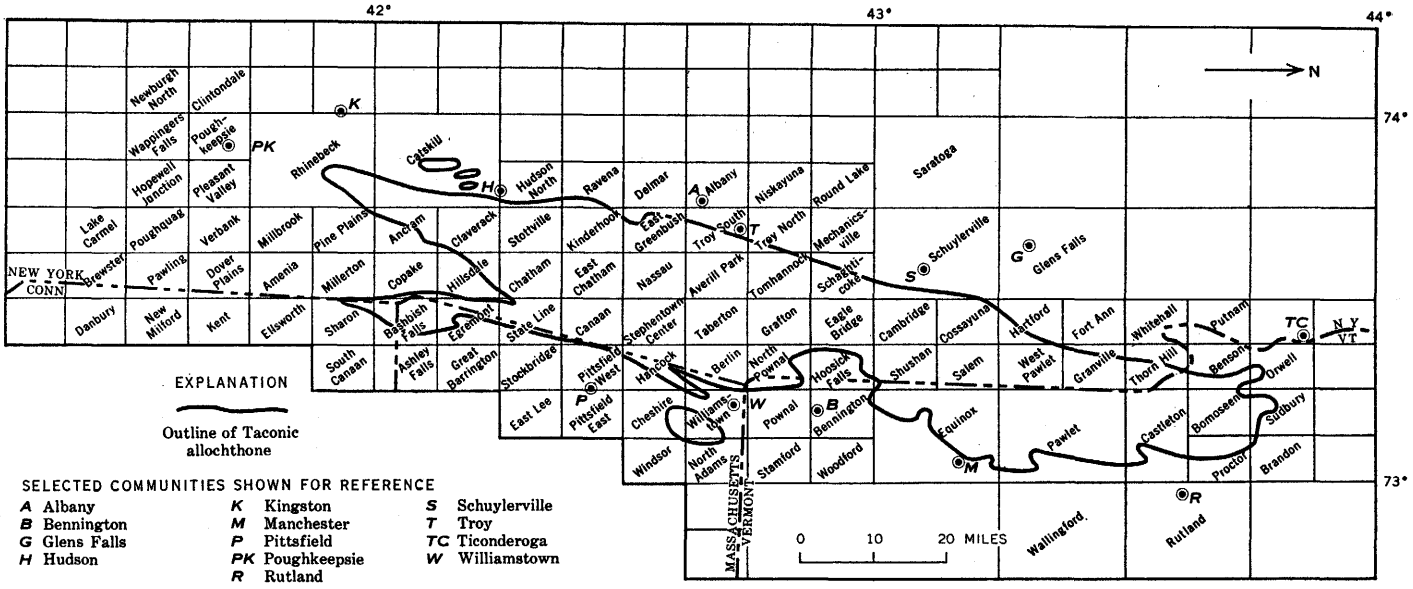

FIGURE 1.—Index of topographic quadrangle maps including the area of the Taconic sequence of rocks, in western Vermont, western Massachusetts, western Connecticut, and eastern New York. The outline of the Taconic allochthone shown is that interpreted by Zen (1960b).

Original description.—Under this heading only lithic descriptions are accepted because the Taconic stratigraphic units are predominately lithologic units. For some rock units, the original reference was not accompanied by lithic characterization; for these a later description by the same author is used where possible and the reference given at the end of the section. For other units, the lithic description is scattered in the text; for these an attempt was made to excerpt or paraphrase the original discussion. For some names, fortunately only a few, no description is given by the original author, and the description by other geologists, who worked on the same rocks in the same areas is then borrowed. This grafting procedure has its obvious intrinsic risks, and is used only as a last resort.

Age.—Although age-diagnostic fossils occur in many rocks of the Taconic sequence, such fossils are by no means everywhere present. In particular, an important part of the sequence lies stratigraphically below the oldest fossil-bearing Lower Cambrian rocks. Therefore, it is not always possible to assign definite ages to the various formations. The practice adopted is to assign a definite age to the entire rock unit that constitutes the smallest formal unit in the classificatory hierarchy, provided the rock unit is fossiliferous or could be definitely correlated with another that is. For rock units that underlie the lowest fossiliferous Lower Cambrian unit that bears a formal rank, and is in normal sedimentary succession thereto, the designation Cambrian(?) is used. For each rock unit whose name is separately discussed here, the age assignment of the original worker is given, followed by a brief discussion of its validity and, whenever possible, the presently accepted age. For a few rock units, no consensus exists for the age, and so the writer's own judgment is recorded. Attempts have been made to indicate clearly the nature of the evidence and the degree of reliability of each age assignment.

Remarks.—In this section are discussed such topics as the history and evolution of the name, the different acceptations of various related names, the equivalence and correlation of rock units from one area to another, and any other pertinent matter.

A word should be said of the use of the term "correlation" in this study. There is no uniform acceptation for this word. For example, Dunbar and Rodgers (1957, p. 271) urge that "correlation" be limited to time correlation of stratigraphic units, whereas Krumbein and Sloss (1951, p. 287) use the term for lithostratigraphic and biostratigraphic as well as for chronostratigraphic units. Rodgers (1959) summarized the respective arguments succinctly. All workers agree that the different possible usages of the term "correlation" should be kept conceptually distinct.

A large part of the Taconic sequence, especially the Lower Cambrian, is, so far, devoid of fossils. These rocks, however, show enough vertical lithic heterogenity in a given section that their subdivision into mappable units (formations) is both feasible and necessary. Evidently, time-stratigraphic correlation of these mappable units from one area to another is impossible unless certain key beds or fossil assemblages be assumed as time-planes. (For another discussion of the problem, see Lochman, 1956.) Even within limited areas, however, the same fauna may be found on both sides of major, regionally significant and traceable formation boundaries that are based on lithic changes. (For instance, the *Elliptocephala asaphoides* fauna is found both in the Bull Formation and in the overlying West Castleton Formation in the northern Taconic region; in this example, the boundary, defined by the colour of the slates, is nearly paralleled by numerous persistent key beds in both units.) If a correlation were made strictly by the biostratigraphic criteria, with their assumed chronostratigraphic significance, the result would obscure completely the essential field relations among the lithostratigraphic units.

In this study, the term "correlation" is reserved for the comparison of rock units that, on the basis either of distinct key beds or of faunal succession or faunal assemblage, are believed to be roughly time-equivalent. If, however, the comparison is based only on lithic resemblance or lithic succession, the term "equivalence" is used. For the Taconic region, in general, the equation of rock units can be carried to much finer detail than the correlation of units. Indeed, one of the gratifying facts of the Taconic problem is that, despite the poor resolving power of the fossil data, the power of lithostratigraphic resolution is so high and the images obtained so consistent throughout most of the Taconic area that a regional synthesis seems eminently possible.

SYNONYMY AND DESCRIPTION

ASHLEY HILL LIMESTONE CONGLOMERATE (OF THE NASSAU FORMATION)

(Bird, 1962, p. 135)

Ashley Hill Cambrian Limestone, Dale, 1892, p. 312.
Ashley Hill Limestone Breccia and Conglomerate (Unit I), Dale, 1904, p. 22.
Limestone Conglomerate of the Schodack Lithofacies, Lochman, 1956, p. 1340.
Ashley Hill Conglomerate (of the Schodack Shale and Limestone), Craddock, 1957, p. 694.
Ashley Hill Limestone, Fisher, 1961, p. D8.

Type locality.—Ashley Hill, town of Chatham, Columbia County, N.Y. (East Chatham 7½-minute quadrangle, New York).

Original description.—"The pebbles are limestone, weather easily, while the cement, which is argillaceous or slaty and in places filled with quartz grains, projects on the surface of the rock" (Dale, 1892, p. 312).

Age.—Early Cambrian (carries the *Elliptocephala asaphoides* fauna).

Remarks.—The fossiliferous Early Cambrian Ashley Hill Limestone Conglomerate, now assigned by Bird to near the top of his enlarged Nassau Formation, is lithically, stratigraphically, as well as faunally (Lochman, 1956, p. 1340; see also Theokritoff, 1959b, p. 1686; Fisher, 1961, p. D8) similar to the North Brittain Limestone Conglomerate Member of the Bull Formation of Zen (1961, p. 303). A correlation is strongly indicated (Dale, 1904, p. 16; Zen, 1961, p. 303; T. W. Talmadge, written communication, 1962).

Dale (1904, p. 16) first compared the limestone conglomerate of Ashley Hill with a nearly identical rock at Schodack Landing. The rock at Schodack Landing is the "Stuyvesant Primordial Beds" of Ford (1885, p. 16), which Ruedemann (1930, p. 80) referred to as the type Schodack Shale and Limestone. Goldring (1943, p. 70) reaffirmed Dale's comparison. Fisher (1961, D8) implied the correlation of the two units, using Ford's name Stuyvesant (conglomerate) and Dale's designation, Ashley Hill Limestone, respectively.

The mutual correlation of the Ashley Hill, the Stuyvesant (=type Schodack, Ruedemann, 1930), and the North Brittain seems generally valid. The "sedimentary slide breccias (brecciolas) (Schodak [sic] Formation)" of Lowman (1961, p. B8; 1962a, p. 221) may be the same unit; they have been so classified by Elam (1960, p. 31).

AUSTERLITZ PHYLLITE

(Fisher, 1961, p. D5)

Berkshire Schist, Dale, 1892, pl. 97.
Nassau Beds, Ruedemann, 1930, p. 83.
Lower Cambrian [Nassau] green slate terrane, Craddock, 1957, p. 691.
Mettawee Slate (of the Nassau Formation), Bird, 1962, p. 135.

Type locality.—Town of Austerlitz, Columbia County, N.Y. (East Chatham and Canaan 7½-minute quadrangles).

Original description.—Purple and green to greenish grey phyllite, carrying chloritoid locally, and interbedded with green chloritic quartzites and subgraywackes.

Age.—Unknown; lithic equivalence and continuity on the ground indicate the unit is probably the same as the pre-Ashley Hill strata of the Nassau Formation, and therefore it is of Cambrian(?) age.

Remarks.—Lithologically, the Austerlitz Phyllite is strongly reminiscent of the "Rowe Schist of the main Taconic Range" of Prindle and Knopf (1932), described by Balk (1953, p. 841). The two rocks may in fact be the same stratigraphic unit. However, Prindle and Knopf show a major thrust fault separating their Rowe Schist from the area now included by Fisher in the Austerlitz Phyllite.

Craddock (1957, p. 691, 692) referred to certain green slates, in the town of Austerlitz and east of the Chatham thrust within the 15-minute Kinderhook quadrangle, as the Nassau Slate. To these rocks he assigned an Early Cambrian age on the basis of the Early Cambrian fauna at Ashley Hill, in a higher stratigraphic unit within the same structural element. The age assignment agrees with Bird's (1962) conclusions of the field relations. (See the Rensselaer Graywacke). The name Austerlitz is almost certainly a synonym of Nassau of Craddock and of Bird (1962a); further work should demonstrate its usefulness.

AUSTIN GLEN MEMBER (OF THE NORMANSKILL FORMATION)

(Ruedemann, 1942a, p. 102)

Normanskill Grit, Ruedemann, *in* Cushing and Ruedemann, 1914, p. 86.
Normanskill Grit, Ruedemann, 1930, p. 98.
Austin Glen Grit Member (of the Normanskill Formation), Goldring, 1943, p. 104.
Austin Glen Unit (of the Normanskill Terrane), Craddock, 1957, p. 689.
Normanskill Graywacke, Potter, 1959.
Austin Glen Greywacke (of the Normanskill Group), Fisher, 1961, p. D9.
Austin Glen Graywacke Member (of the Normanskill Shale), Berry, 1962, p. 712.

Type locality.—Austin Glen, town of Catskill, N.Y. (Catskill 15-minute quadrangle, New York).

Original description.—"Grit with thin shale intercalations."

Age.—Middle Ordovician (zones 12 and 13 of the Marathon graptolite succession; Berry, 1960; 1962, p. 714).

Remarks.—By lithology and by sequence, the Austin Glen is equivalent to the Pawlet Formation of the northern Taconic region. A correlation is confirmed by a comparison of their graptolite faunas (Ruedemann, 1942a; Goldring, 1943; Berry, 1959; 1962, p. 713). At the south end of the Taconic region, the Austin Glen has been called a member of the Normanskill; at the north end, however, its equivalent is designated the Pawlet Formation (Zen, 1961; in press; Doll and others, 1961).

BALD MOUNTAIN LIMESTONE

(Mather, 1843, p. 367)

Mohawk Limestone, Mather, 1841, p. 99.

Bald Mountain Limestone+Rysedorph Hill Conglomerate (=Rysedorph Conglomerate, in part)+other units, Ruedemann, *in* Cushing and Ruedemann, 1914, p. 76.

Beekmantown Dolomite+pebbles and boulders of other rocks types, Billings and others, 1952, p. 49.

Type locality.—Bald Mountain, town of Greenwich, N.Y. (Schuylerville 15-minute quadrangle, New York).

Original description.—"Unit 6: thin-bedded black limestone * * *; Unit 5: thicker-bedded gray aphanitic limestone * * *; Unit 4: thick-bedded light-gray nonsandy dolostone * * *; Unit 3: thick-bedded light-gray limestone * * *; Unit 2: very sandy dolostone-dolomitic sandstone, light-gray, cross-stratified * * *; Unit 1: laminated dolostone, outcrops showing distinctive 'striped' appearance * * *" (Sanders and others, 1961, p. 485–486).

Age.—The limestone was originally assigned to the Black River by Mather; however, the sequence is at least as old as the Beekmantown, but it may even include Cambrian rocks. The youngest limestone, the limestone "pebbles" in the shale, and the black shale itself are Trenton in age (Ruedemann, *in* Cushing and Ruedemann, 1914, p. 77).

Remarks.—The origin and age of the Bald Mountain Limestone and related rocks are subjects of considerable controversy. As far as the writer is aware, no detailed lithic separation within the Bald Mountain Limestone had been made before Sanders and others (1961); their lithic description is adopted here.

It is quite possible that Mather (1843) applied the name Bald Mountain Limestone only to the upper part of the carbonate sequence that contained Middle Ordovician fossils. Ruedemann *in* Cushing and Reudemann, 1914), however, extended the use of the name to the entire belt of carbonate rocks, some 5 miles long and half a mile wide, between Bald Moutain and Louse Hill near Middle Falls, N.Y.; he discussed previous studies on the rock sequence and concluded that the carbonate sequence is Beekmantown (1914, p. 77), although he noted that some of the cherty dolostone lithically resemble the Little Falls (p. 79). Sanders and others (1961, p. 486) pointed out that Ruedemann's Beekmantown fossils were obtained from their Unit 4, so that the base of the sequence may indeed be pre-Beekmantown. It seems clear, from the description of Sanders and others, that the Bald Mountain Limestone is an inclusive name for rocks whose lithic equivalents elsewhere have been assigned to several discrete formations.

The Bald Mountain Limestone of Ruedemann is succeeded at Bald Mountain quarry by a slate-matrix, limestone-block unit that is the subject of much discussion. Ruedemann (*in* Cushing and Ruedemann, 1914. p. 83) considered this unit in part a mylonite in front of the Taconic thrust, and in part the correlative of the Rysedorph Hill (=Rysedorph) Conglomorate; Trenton fossils from the matrix and from some of the blocks corroborate this correlation. Rodgers (*in* Billings and others, 1952) summarized the extant hypotheses and problem, adding the suggestion that the limestone in the Bald Mountain quarry may be gigantic blocks as part of the polymict conglomerate.

Sanders and others (1961, p. 486) made a new study of the Bald Mountain quarry and suggested that the irregular contact of the limestone and the black shale is due to deposition of the shale on a karst topography and that the limestone "blocks" are part of the main mass of the Bald Mountain Limestone. These workers also reported the presence of the Rysedorph Conglomerate, but as did Kay (1937, p. 277), stated that the conglomerate cannot be genetically related to the Taconic thrust because limestones lithically resembling those of the autochthone constitute the boulders and pebbles.

Sanders and others (1961) did not discuss the structural position of the Bald Mountain carbonate sequence as a whole. Ruedemann (*in* Cushing and Ruedemann, 1914, p. 80) pointed out that the sequence overlies the Snake Hill Shale to the west, and underlies the Taconic rocks to the east, with fault contacts. Rodgers (*in* Billings and others, 1952, p. 49) suggested that the area consists of two slices. One, the western slice, "consists of dolomite clearly belonging to the western carbonate sequence and therefore roughly autochthonous"; the second, eastern slice, "consists of the black slate with limestone fragments and the enclosed pure quarry limestone" (Ruedemann's mylonite and Rysedorph Conglomerate). Rodgers explained the eastern slice as "merely mammouth boulders in a piece of Rysedorph Hill Conglomerate caught up as a slice along the fault, in other words, the whole east slice is a sedimentary breccia, itself somewhat brecciated along the fault."

The writer, in the company of J. M. Bird, reexamined the Bald Mountain quarry in September 1962. The limestone blocks in the quarry are separated from one another by septa of black slate which, though at places very thin, are persistent. The black slate matrix also contains blocks, as much as 2 feet across, of a brown-weathering sandstone with calcareous matrix, lithically identical with the Taconic rocks immediately overlying the black shale at the lip of the quarry.

About 1 mile north along the road west of Bald Mountain, the position of this polymict rock under the Taconic rocks is taken by a black slate-matrix, slate- and sandstone-block conglomerate identical with the Forbes Hill Conglomerate of Zen (1961, p. 311). The relations seem to confirm Rodgers' suggestion and are also in accord with the finding of blocks of Taconic rocks in an outcrop of conglomerate near the type Rysedorph (see Rysedorph Conglomerate for details); these data tend to obviate the objections of Kay and of Sanders and others, mentioned above.

Because of its position between the Snake Hill Shale below and the older Taconic rocks above, the Bald Mountain Limestone seems to be a tectonic sliver, dragged into the present position at the sole of the Taconic thrust. Such tectonic slices are well documented elsewhere in the Taconic region, as has been detailed under the Tackawasick Limestone; other possible examples, on a larger scale, are the Sudbury thrust slice (Zen, 1961, p. 321) and the extensive area of Lower Ordovician carbonate rocks around Dorset Mountain, Vt. (Thompson, 1959, map).

BARKER QUARTZITE

(Swinnerton, 1922, p. 65; Keith, 1932, p. 401)

Bird Mountain Grit and Conglomerate, Dale, 1893, p. 338.
Ferruginous Quartzite (Unit E; in part), Dale, 1899, p. 183.
Bird Mountain Grit+Zion Hill Formation, Kaiser, 1945, p. 1089.
Zion Hill Quartzite, Fowler, 1950, p. 53.
Zion Hill Quartzite and Graywacke Member (of the Bull Formation), Zen, 1961, p. 302.

Type locality.—Barker Hill, town of Castleton, Vt. (Bomoseen 7½-minute quadrangle.)

Original description.—"Generally light or white * * * on weathered surfaces, but is more or less green when freshly broken. It varies also in coarseness from a dense rock with very fine grains of quartz to a coarse quartzite and locally a fine conglomerate. The coarser facies contain pebbles of various slates, quartzites, and a little limestone" (Keith, 1932, p. 401).

Age.—Originally assigned to the Cambrian. The rock has not yielded fossils; however, the North Brittain Conglomerate, which is Early Cambrian, overlies the Barker in a continuous sedimentary series. The Barker should be Cambrian (?) in age.

Remarks.—An exact synonym of the Zion Hill Quartzite. See discussion under that name.

BEEBE LIMESTONE MEMBER (OF THE WEST CASTLETON FORMATION)

(Zen, 1961, p. 304)

Limestone, Swinnerton, 1922, p. 71.
Beebe Limestone, Keith, 1932, p. 402.
Beebe Limestone, Schuchert, 1937, p. 1039.

Type locality.—East and southeast of Beebe Pond, town of Hubbardton, Vt. (Bomoseen 7½-minute quadrangle).

Original description.—"A black, fine-grained, massive limestone, weathering dark gray and abundantly criss-crossed with calcite veins, * * * near the base of the [West Castleton] formation. It may be as much as 20 feet thick, but it is commonly absent."

Age.—Early Cambrian (carries the *Elliptocephala asaphoides* fauna).

Remarks.—Keith established the Beebe as a separate unit, apparently of formation rank, because within the Taconic sequence it is lithically distinct and faunally significant. The limestone, however, is interbedded with the slate of the West Castleton Formation and is not everywhere present. Zen (1961) therefore designated it a member of the West Castleton Formation.

BELLOWSPIPE LIMESTONE

(Dale, 1891, p. 5)

Beekmantown marble, Prindle and Knopf, 1932, p. 273. (See also p. 295.)
Schistose marble (of the Berkshire Schist), Herz, 1958.
Schistose marble (of the Berkshire Schist), Herz, 1961.

Type locality.—Bellows Pipe, Mount Greylock, in the town of Adams, Mass. (Williamstown 7½-minute quadrangle).

Original description.—"Limestone more or less crystalline, generally micaceous or pyritiferous, passing into a calcareous mica schist or a feldspathic quartzite or a fine grained gneiss."

Age.—Originally assigned to the Ordovician. The compiler, however, would assign the rock to the Cambrian(?) by comparison with equivalent rocks assigned to this age designation, in the northern Taconic region on the one hand, and in the eastern Vermont sequence on the other. (See Doll and others, 1961.)

Remarks.—Dale designated an impure argillaceous to quartzose limestone or marble on Mount Greylock as the Bellowspipe Limestone. The rock is stratigraphically below the Greylock Schist and above the Berkshire Schist. Because the limestone was presumed to be part of a conformable Ordovician sequence, an Ordovician age was assigned to it.

Prindle and Knopf (1932, p. 295) considered the limestone to be part of the Lower Ordovician marble sequence referred to by Dale (1891, p. 6) as the Stockbridge Limestone. They assigned the Berkshire and Greylock Schists of the mountain mass to the Lower Cambrian, however, and a folded thrust contact was shown to surround tectonic windows of the limestone areas. This interpretation was rejected by Herz (1958; 1961) who reverted to the views of Dale. Herz, however, did not separately map the Bellowspipe as a formation but showed it as lentils within the upper part of the Berkshire Schist; Dale used the lower and upper contacts of this marble as the upper and lower limits, respectively, of his Berkshire and Greylock Schists.

The Egremont Limestone of Hobbs (1893), as emended (Hobbs, 1897) and renamed the Bellowspipe, may correspond to the type Bellowspipe. Hobbs included black schists in his Egremont; these schists are more likely the Berkshire Schist as used by Dale (1891) (Zen, unpublished data).

Dale used the names Bellowspipe Quartzite (1894a, pl. 71) for a white quartzite on Monument Mountain north of Great Barrington, Mass.; he later (1923) reassigned the rock to the Cheshire Quartzite. Dale also used the term Bellowspipe Formation (1894a, p. 559, 562) as a synonym of his Bellowspipe Quartzite; this usage emphasizes the fact that the unit overlies the Berkshire Schist. Wilmarth (1938, p. 155) stated that Dale intended his Bellowspipe Formation to include both the Bellowspipe Limestone and the Greylock Schist. This view is untenable, as may be ascertained by a careful comparison of Dale's discussions on the lithology and thickness of the Bellowspipe Formation and the Bellowspipe Limestone.

BENSON BLACK SLATE

(Dale, 1899, pl. 13)

Synonymy.—See remarks below.

Type locality.—None given specifically; but rocks shown as outcropping around the village of Benson, town of Benson, Vt. (Benson 7½-minute quadrangle, Vermont-New York).

Original description.—None given.

Age.—Originally assigned to the Cambrian or Ordovician; the rock unit is now generally considered to be part of the Hortonville Slate and therefore is Middle Ordovician in age.

Remarks.—The Benson Slate, as well as the "Lower Silurian (Ordovician)" slate near Wilcox Hill in Benson and around Hortonville (but not the other areas of Dale's Lower Silurian slate), shown on Dale's geologic map (1899, pl. 13) are what Rodgers (1937, p. 1579) referred to as the "shale of the Trenton formation," and what Keith

(1932), Cady (1945), and later workers called the Hortonville Slate. See section on "Hortonville Slate" for further discussion.

BERKSHIRE SCHIST

(Dale, 1891, p. 6)

Synonymy.—See remarks below.

Type locality.—Berkshire County, Mass.

Original description.—"[The Berkshire Schist] consists of the lower sericite schists [of Mount Greylock]. The groundmass of these schists is made up of interlacing fibers of muscovite (sericite) and folia of chlorite and grains of quartz * * *. The color of these schists varies with the varying proportions of * * * muscovite, chlorite, and quartz. Often it is black from the presence of graphite, or porphyritic from the presence of feldspar, or spangled from the presence of other minerals. Quartz lenses and seams are almost universal * * *. The rock is sometimes calcareous, but not continuously so" (Dale, 1894b, p. 182–184).

Age.—Originally assigned to the "Silurian" (=Ordovician); the rock is probably, at least to a large extent, the same as the Walloomsac Slate and thus of Middle Ordovician age.

Remarks.—The meaning of the term Berkshire Schist has become vague. Dale's original definition (1891) for the Mount Greylock area, amplified in his 1894b report, was the most specific, and it excluded certain green schist beds which he called the Greylock Schist. In this restricted sense, the Berkshire Schist was correlated by Hobbs (1893) with his Riga Schist. Dale (1899; 1900; 1912; 1923), however, showed Berkshire Schist in areas that include rocks closely resembling the Greylock Schist. In these later references, the term Berkshire Schist was used in an expanded sense to include all argillites above the carbonates of Dale's Stockbridge Limestone or its equivalents. The expanded sense of the name was used by Emerson (1917) and by Gregory and Robinson (1907).

The precise assignment of the rocks called the Berkshire Schist to more specific stratigraphic units is an integral part of the Taconic stratigraphic-structural problem; there is little uniformity or even consistency of opinion among Taconic geologists. Discussions of these specific stratigraphic units are given elsewhere in this paper; the following names, in whole or in part, have been used to cover the terrane of the expanded Berkshire Schist of Dale: Stiles Phyllite (Keith, 1932), Hubbardton Slate (Keith, 1932), Brezee Phyllite (Keith, 1932), Brezee Formation (Doll and others, 1961), Schodack Formation (Kaiser, 1945; Fowler, 1950), Ira Slate (Keith, 1932), Ira Formation (Zen, 1961; Thompson, 1959), Hortonville Slate

(Fowler, 1950; Billings and others, 1952), Hortonville Formation (Doll and others, 1961), Mettawee Slate (Kaiser, 1945; Fowler, 1950), Bull Formation (Zen, 1961), St. Catherine Formation (Doll and others, 1961), Greylock Schist (Thompson, 1959), Rowe Schist (Larrabee, 1939; Prindle and Knopf, 1932), Walloomsac Slate (MacFadyen, 1956; Prindle and Knopf, 1932; Potter, 1959; Fisher, 1961), Mount Anthony Formation (MacFadyen, 1956; Hewitt, 1961b), Normanskill Shale (Prindle and Knopf, 1932), Normanskill Formation (Potter, 1959), Riga Schist (Hobbs, 1893), Salisbury Schist (Agar, 1932; Rodgers and others, 1959), Nassau Formation (Fowler, 1950; Billings and others, 1952), West Castleton Formation (Zen, 1961), Biddie Knob Formation (Zen, 1961), Austerlitz Phyllite (Fisher, 1961), Everett Schist (Hobbs, 1893; Fisher, 1961), and possibly other names.

BIDDIE KNOB FORMATION

(Zen, 1961, p. 299)

Berkshire Schist (Unit Sb, in part)+Cambrian Roofing Slate (Unit B, in part), Dale, 1899, p. 180, 191.
Berkshire Schist (in part), Dale, 1900, p. 19.
Berkshire Schist (in part), Dale, 1912, pl. 1.
Wallace Slate (in part)+Stiles Phyllite (in part), Swinnerton, 1922, p. 63.
Stiles Phyllite (in part)+Hubbardton Slate (in part), Keith, 1932, p. 400, 401.
Wallace Ledge Formation (in part)+Mettawee Slate (in part), Kaiser, 1945, p. 1085, 1089.
Mettawee Slate (in part)+Nassau Formation (in part)+Wallace Ledge Slate (in part), Fowler, 1950, p. 38, 47, pl. 2.
Greylock Schist (in part), Thompson, 1959, p. 77.
St. Catherine Formation (in part), Doll and others, 1961.

Type locality.—West and south slopes of Biddie Knob, town of Pittsford, Vt. (Proctor 7½-minute quadrangle, Vermont).

Original description.—Purple and green, chloritoid-bearing slate and phyllite, and subsidiary quartzite and rare thin limestone (Zen, 1961, p. 299).

Age.—Originally designated Cambrian. The lowest fossiliferous bed in the stratigraphic section, however, is the North Brittain Conglomerate of the overlying Bull Formation, with which the Biddie Knob is in apparent sedimentary continuity. The probable age of the Biddie Knob therefore must be Cambrian(?).

Remarks.—The Berkshire Schist of Dale, the Stiles Phyllite of Keith and of Swinnerton, the Hubbardton Slate of Keith, the Wallace Slate of Swinnerton, and the Wallace Ledge Formation of Kaiser are all partly Zen's Biddie Knob. Among these names, the Hubbardton Slate, the Wallace Slate, and the Wallace Ledge Forma-

tion are most nearly identical with the Biddie Knob; however, the bases of definition differ. The Biddie Knob was defined on the presence of chloritoid, but the other units were defined as the purple and green slate underlying the Zion Hill (or Barker) quartzite; the slate beds immediately beneath the quartzite are commonly non-chloritoid bearing and, therefore, part of Zen's Bull Formation.

Dale (1899, p. 191) described abundant "actinolite" crystals in his Berkshire Schist. The "actinolite" proved to be chloritoid (Zen, 1960a, p. 156), and the rocks involved were mapped by Zen (1961; in press) as part of the Biddie Knob. Thompson (1959, p. 77) correlated part of his Greylock Schist in the Pawlet quadrangle with the Biddie Knob; the rock in question is also part of Dale's (1912) Berkshire Schist.

Despite discrepancies in the assigned ages, the equation of part of the Mount Anthony Formation of MacFadyen (1956, p. 28) and of Hewitt (1961b, p. 32), of the Greylock Schist of Dale (1891) and of Herz (1958; 1961), of part of the "Rowe Schist on Mount Greylock and of the Taconic Range" of Prindle and Knopf (1932), of the Austerlitz Phyllite of Fisher (1961), of part of the Everett Schist of Hobbs (1893), of part of the Berkshire Schist of Emerson (1917), and of part of the Salisbury Schist of Rodgers and others (1959), seems justified on lithic similarity and stratigraphic succession, even though the correlation of these units is not demonstrated.

BIRD MOUNTAIN GRIT

(Dale, 1893, p. 338; 1900, p. 16)

Barker Quartzite, Keith, 1932, p. 401.
Barker Quartzite, Swinnerton, 1922, p. 196.
Zion Hill Formation, Kaiser, 1945, p. 1089.
Bird Mountain Grit (of the Nassau Formation), Fowler, 1950, p. 38.
Zion Hill Quartzite and Graywacke (member of the Bull Formation), Zen, 1961, p. 303.
Zion Hill Quartzite Member (of the St. Catherine Formation), Doll and others, 1961.

Type locality.—Bird Mountain, towns of Castleton, Ira, and Poultney, Vt. (Castleton 15-minute quadrangle, Vermont-New York).

Original description.—"[A] conglomerate consisting of quartz pebbles (of granite, gneiss, or vein origin) often showing signs of compression, of pebbles of limestone and of quartzite with calcite cement, of pebbles having a dark-brown limonitic matrix inclosing flakes of muscovite and chlorite, and of clastic grains of tourmaline; all in a cement of chlorite, muscovite (sericite), quartz (partly secondary), calcite in grains and in vein-like masses with columnar

crystallization, and some grains of pyrite, magnetite, and titanite [and graphite]" (Dale, 1900, p. 17).

Age.—Originally assigned a post-Chazyan age by Dale. However, the unit is now identified with and mapped as the Zion Hill Quartzite and Graywacke Member of the Bull Formation (Zen, 1961; in press); it thus is Cambrian(?) in age.

Remarks.—The Bird Mountain Grit has been correlated and equated with the Zion Hill Quartzite (=Barker Quartzite) by Kaiser, Swinnerton, Keith, and Zen on the basis of its lithology and stratigraphic succession. This identification seems very plausible. Historically, Dale (1900, p. 21) suggested that the grit is post-Chazyan, because it overlies the "Berkshire Schist," which in turn overlies Chazyan carbonate rocks of the Vermont Valley. The other dissenter on the stated identification was Fowler (1950, p. 54), who called the phyllites surrounding and underlying the Bird Mountain Grit the Nassau Formation. Inasmuch as Fowler thought the age of the Nassau was pre-Mettawee and that of the Zion Hill post-Mettawee (post-Schodack in fact), he could not identify the Bird Mountain Grit with the Zion Hill Quartzite. Fowler's views were rejected by Zen (in press).

Dale's (1892, p. 337), original suggestion that the Bird Mountain Grit and the Rensselaer Graywacke are correlatives of each other, though plausible, probably can never be proved because of the wide separation of the areas. For further discussion, see section on "Rensselaer Graywacke."

BOMOSEEN GRAYWACKE (MEMBER OF THE BULL FORMATION)

(Zen, 1961, p. 301)

Olive Grit (Unit A), Dale, 1899, p. 179.
Bomoseen Grit, Ruedemann, *in* Cushing and Ruedemann, 1914, p. 69.
Bomoseen Grit, Resser and Howell, 1938, p. 203.
Bomoseen Grit, Larrabee, 1939, p. 48.
Bomoseen Formation, Howell and others, 1944, column 69.
Bomoseen Grit, Kaiser, 1945, p. 1085.
Bomoseen Grit, Fowler, 1950, p. 46.
Bomoseen Graywacke Member (of the St. Catherine Formation), Doll and others, 1961.

Type locality.—West side of the outlet of Lake Bomoseen near Hydeville, town of Castleton, Vt. (Castleton 15-minute quadrangle, Vermont-New York).

Original description.—"The Bomoseen graywacke is typically hard and poorly cleaved. It is olive gray and weathers white or pale brick red. On a fresh surface flakes of white mica can be seen, aligned parallel to the cleavage. Grains of quartz and feldspar as

much as 1 mm across are common, and dark fragments of rocks are found, although rarely. Locally * * * it is interbedded with many white quartzite beds, each a few feet thick and lithologically like the Mudd Pond Quartzite Member [of the Bull Formation]."

Age.—Originally given an Early Cambrian age. The unit is in a conformable sequence with, but underlies, the fossiliferous North Brittain Conglomerate Member of the Bull Formation and is, therefore, Cambrian(?) in age.

Remarks.—Zen (1959) first suggested that the Bomoseen does not everywhere underlie the Mettawee Slate, as generally supposed. This fact is now also shown to be true for the area immediately west of the Rensselaer Plateau in Colombia and Rensselaer Counties, N.Y. (Bird, 1962, p. 136). However, all workers agree that near the western edge of the Taconic belt, the Bomoseen does form the basal unit of the exposed Taconic sequence.

The Bomoseen lithology has been generally recognized in the southern Taconic region. This lithology is the lower part of Unit A, and possibly Unit F, of Dale (1904, p. 29); the Bomoseen Grit of Ruedemann (*in* Cushing and Ruedemann, 1914, p. 69; 1930, p. 83; 1942a, p. 42) and of Goldring (1943, p. 65), the Bomoseen Subgraywacke of Fisher (1961, p. D6), the Bomoseen Siltstone of Potter (1959), and of corresponding units of Elam (1960) and Platt (1960). Bird (1962a, p. 136) included the Bomoseen in his Nassau Formation, just as Zen included this rock in the Bull Formation, with which Bird correlated his Nassau.

BREZEE FORMATION

(Doll and others, 1961)

Berkshire Schist (Unit Sb), Dale, 1899, p. 191.

Brezee Phyllite+Stiles Phyllite (in part)+Ira Slate+other units(?), Keith, 1932, p. 399, 400.

Mettawee Slate (in part)+Schodack Formation (in part), Kaiser, 1945, p. 1085, 1087.

Mettawee Slate (in part)+Schodack Formation (in part)+Hortonville Slate (in part), Fowler, 1950, pl. 2.

West Castleton Formation(?)+Mount Hamilton Group(?)+Ira Slate+Hortonville Slate (in part), Zen, 1961, p. 304, 306, 310, pl. 1.

Bull Formation(?) (in part)+West Castleton Formation (in part)+Poultney Slate(?)+Ira Formation (in part), Zen, in press.

Berkshire Schist, Thompson, 1959, p. 77.

Mount Anthony Formation (in part), Hewitt, 1961b, p. 32.

Type locality.—None given.

Original description.—"Dark gray to black phyllite with beds of blue-gray marble, dark gray dolomite, sandy dolomite, and dolomitic sandstone, in upper part; beds of massive quartzite as much as 20 feet

thick occur locally and in places contain pebbles of blue quartz. Phyllites are locally highly albitic. [Also included is a] quartzose green phyllite."

Age.—Assigned by Doll and others to the Cambrian(?) and Early Cambrian. The reason for this assignment was unspecified. Inasmuch as lower Cambrian fossils have been reported from a limestone outcrop included in the Brezee Formation (see "Remarks" below), an Early Cambrian age is clear. Such an age would also accord with Zen's identification of the Brezees Formation, at least in part, with the West Castleton Formation of Early Cambrian age (Zen, 1963).

Remarks.—The Brezee Phyllite of Keith (1932) is basal to the Taconic sequence and includes carbonate rocks and calcareous sandstones as well as the dominant black to gray slate and phyllite. Its areal distribution is confined to the northern extremity of the Taconic region (Keith, ms. map, U.S. Archives). The Brezee Formation of Doll and others is nearly synonymous with Keith's Brezee Phyllite, except that green phyllites of uncertain classification have also been included in the former.

The Brezee Formation of Doll and others (1961) includes, at the extreme north end of the Taconic region, lithic units closely resembling the Hatch Hill Formation and the Beebe Limestone Member of the West Castleton Formation. In fact, one of the limestone outcrops that lithically resembles the Beebe has yielded Lower Cambrian fossils (Swinnerton, 1922, p. 79; see also Zen, 1961, p. 305). It is likely that at least part of the Brezee Formation of Doll and others will prove to be the West Castleton Formation. Within the same area of the Brezee Formation, there are small patches of the Forbes Hill Conglomerate, part of the autochthonous Hortonville Slate (Zen, 1961). The use of the name Brezee Formation has been discussed by Zen (1963) and by Doll and others (1963).

In some localities around Dorset Mountain, the Brezee Formation was mapped as the Berkshire Schist by Thompson (1959, pl. H–1). Thompson (1959, p. 77) suggested that the black schist of this area may be at least partially equivalent to the Middle Ordovician Ira Formation (= Hortonville Formation, Doll and others, 1961). Areas in the Equinox quadrangle in Vermont, shown by Doll and others as the Breeze Formation, were mapped by Hewitt (1961b) as part of his Mount Anthony Formation.

BREZEE PHYLLITE

(Keith, 1932, p. 399)

Berkshire Schist (Unit Sb), Dale, 1899, p. 191.
Schodack Formation (in part), Kaiser, 1945, p. 1087.
Schodack Formation (in part) + Hortonville Slate (in part), Fowler, 1950, pl. 2.

West Castleton Formation(?) (in part)+Mount Hamilton Group(?)+Ira Formation (in part)+Hortonville Slate (in part), Zen, 1961, p. 304, 306, 310.
Brezee Formation (in part), Doll and others, 1961.

Type locality.—Brezee Mill Brook, towns of Brandon, Sudbury, and Hubbardton, Vt. (Bomoseen and Sudbury 7½-minute quadrangles).

Original description.—"Slate or phyllite of a dark or bluish-gray color. Much of it is banded with light gray, and its weathered surfaces are apt to have a brownish or dull greenish gray color."

Age.—Assigned to the Early Cambrian by Keith. Keith's geologic map (U. S. Archives) does not make it clear, however, whether the outcrop bearing Lower Cambrian fossils, near Keeler Pond in the town of Sudbury (Swinnerton, 1922, p. 79; see also Zen, 1961, p. 305) was included in his Brezee Phyllite. If it was not, then the proper age assignment should be Cambrian(?) because Keith thought the rock conformably underlies fossiliferous Lower Cambrian units.

Remarks.—The term Brezee Phyllite was originally proposed for a Lower Cambrian rock unit by Keith. Zen (1961) mapped the main part of Keith's Brezee Phyllite as the West Castleton Formation, also of Early Cambrian age, but he labeled other parts West Castleton(?)-Mount Hamilton(?)-Ira(?) because of difficulties in distinguishing these unfossiliferous black slates. The Brezee of Keith includes a calcareous quartzite that is lithically similar to the quartzite of the Hatch Hill Formation (Keith, 1932, p. 400; Zen, 1961, p. 307).

BULL FORMATION

(Zen, 1961, p. 300)

Olive Grit (Unit A)+Cambrian Roofing Slate (Unit B)+Black Patch Grit (Unit C; in part)+Ferruginous Quartzite (Unite E; in part)+Berkshire Schist (Unit Sb; in part), Dale 1899, table facing p. 178.
Berkshire Schist (in part)+Bird Mountain Grit, Dale, 1900, pl. 1.
Wallace Slate (in part)+Barker Quartzite+Bull Slate+Stiles Phyllite (in part), Swinnerton, 1922, p. 63, 65, 69, map.
Hubbardton Slate (in part)+Barker Quartzite+Bull Slate+Stiles Phyllite (in part), Keith, 1932, p. 400, 401.
Rowe Schist+Mettawee Slate+Bomoseen Grit, Larrabee, 1939, p. 48, 49.
Mettawee Slate (in part)+Schodack Formation (in part)+Eddy Hill Grit (in part)+Bomoseen Grit+Bird Mountain Grit+Zion Hill Quartzite+Wallace Ledge Formation (in part)+Berkshire Schist (in part, Kaiser's original correlation), Kaiser, 1945, p. 1085, 1086, 1087, 1089.
Mettawee Slate (in part)+Schodack Formation (in part)+Nassau Formation (in part)+Zion Hill Quartzite+Bomoseen Grit+Eddy Hill Grit (in part?), Fowler, 1950, p. 38, 46, 47, 49, 50, 53.
St. Catherine Formation (in part)+Brezee Formation(?, in part), Doll and others, 1961.

Type locality.—Bull Hill, town of Castleton, Vt. (Bomoseen 7½-minute quadrangle, Vermont).

Original description.—Dominantly purple and green slate (the Mettawee Slate Facies), but includes an orthoquartzite (the Mudd Pond Quartzite Member), a graywacke (the Bomoseen Graywacke Member), a subgraywacke-quartzite (the Zion Hill Quartzite and Graywacke Member), and a limestone pebble conglomerate (the North Brittain Conglomerate Member). (Zen, 1961, p. 300.)

Age.—Designated Early Cambrian by Zen (1961), because the North Brittain Conglomerate Member carries the *Elliptocephala asaphoides* fauna. The lower part of the formation nevertheless has so far not yielded fossils, the age of the unit therefore should be Cambrian(?) and Early Cambrian.

Remarks.—The name Bull Formation was used by Zen (1961) for a heterogeneous rock unit as indicated above. Many of the names listed in the synonymy, such as Bull, Bomoseen, Zion Hill, and Mettawee, have been used by authors for rocks in other areas within the Taconic region whereas names such as Nassau and Schodack have been borrowed from other areas and used for rocks at the north end of the Taconic region, that may be demonstrated as part of the Bull Formation (compare, for example, Kaiser, 1945; Zen, 1961). Interpretations of these two-way long-distance equations and correlations are difficult, hazardous, and inevitably somewhat subjective; the writer's own views follow.

The Bull Formation probably should be equated with Units A through H of Dale's 1904 report, or, in terms of Ruedemann's names, with the Nassau Beds, the Bomoseen Grit, the Diamond Rock Quartzite, and the Troy Shale (Ruedemann, *in* Cushing and Ruedemann, 1914, p. 69–70; Ruedemann, 1930, p. 79; 1942a, p. 63; Goldring, 1943, p. 51). Dale's 1904 section may contain structural repetitions, which complicate the detailed stratigraphic comparison. Zen (1961, p. 303) suggested an equivalence of the Rensselaer-like graywacke beds in the Nassau of Craddock (1957, p. 691) with the Zion Hill of his Bull Formation. This lithic comparison is strengthened by the stratigraphy of the two areas; the Ashley Hill Conglomerate of Craddock (=Dale's Unit I, 1904) placed near the top of the Nassau Formation by Bird (1962a, p. 136), is similar to Zen's North Brittain Conglomerate. Bird (1962a), in fact, suggested the lateral facies equivalence of the Rensselaer Greywacke with the lower part of the Mettawee Slate as well as with the Bomoseen Greywacke; he included all of Dale's 1904 Lower Cambrian succession, except possibly the top strata of Unit J, in his Nassau Formation, and correlated the Nassau with Zen's Bull Formation. However, Dale's Units A and C may contain part of rocks comparable with Zen's Biddle Knob Formation (J. M. Bird, written communication, 1961).

Reconnaissance observations by the writer in the Copake quadrangle, New York, showed that Weaver's (1957, p. 739) Elizaville Shales and "gray-green quartzite", and possibly also his "calcareous grit", are at least in part comparable with units of the Bull Formation of the northern Taconic region. Such an equation for at least a part of Weaver's section has been made by Fisher (1961, p. D6), although stratigraphic details are as yet lacking for its confirmation.

The Mettawee Slate and the "shales and grits of Lower Cambrian age" of Prindle and Knopf (1932, p. 275, 276), as well as their Rensselaer Graywacke (1932, p. 280), seem almost certainly to be equivalent to parts of the Bull Formation of Zen.

The Rowe Schist and Hoosac Schist of Prindle and Knopf (1932, p. 284), part of the St. Catherine Formation of Doll and others (1961), the Mount Anthony Formation of MacFadyen (1956), part of the Mount Anthony Formation of Hewitt (1961b), the Austerlitz Phyllite of Fisher (1961, p. D5), the Greylock Schist and Berkshire Schist of Dale (1891) and of Herz (1958; 1961), the Greylock Schist of Thompson (1959, p. 77), the Berkshire Schist of Dale (1912; 1923), the Everett Schist of Hobbs (1893), the Berkshire Schist of Weaver (1957), the Berkshire Schist of Gregory and Robinson (1907), and the Salisbury Schist of Agar (1932) and of Rodgers and others (1959), may be in part correlative with the Bull Formation of Zen. At the present time, however, these possibilities are no more than guesses; they remain one of the principal problems in Taconic geology.

BULL SLATE

(Swinnerton, 1922, p. 69; Keith, 1932, p. 360, 401)

Cambrian Roofing Slate (Unit B; in part), Dale, 1899, p. 180.
Mettawee Slate, Larrabee, 1939, p. 48.
Mettawee Slate (in part)+Schodack Formation (in part), Kaiser, 1945, p. 1085, 1087.
Mettawee Slate (in part), Fowler, 1950, p. 47.
Mettawee Slate Facies (of the Bull Formation; in part), Zen, 1961, p. 300.
St. Catherine Formation (in part), Doll and others, 1961.

Type locality.—Quarry on Bull Hill, town of Castleton, Vt. (Bomoseen 7½-minute quadrange).

Original description.—"The slate is usually of a purplish color more or less mixed with green * * *. [It] has a fine, even grain and smooth texture and the banding is so faint that as a rule it does not affect the smoothness of the cleavage. There are only a few sandstone layers * * * and occasionally a small bed of limestone appears in the upper part of the slate" (Keith, 1932, p. 401–402).

Age.—Early Cambrian because, as defined, the rock includes the fossiliferous limestone conglomerate now called the North Brittain.

Remarks.—As originally defined by Swinnerton and followed by Keith, the Bull Slate is confined to the strata above the Barker Quartzite and below the Beebe Limestone (below the Hooker Slate according to Swinnerton, who did not separately map the Beebe Limestone). The Mettawee Slate of authors, the Mettawee Slate Facies of Zen, and the Cambrian Roofing Slate of Dale, however, include also part of the Hubbardton Slate of Keith, part of the Wallace Slate of Swinnerton and possibly part of the Stiles Phyllite of Keith and Swinnerton, in addition to the Bull Slate of Keith and Swinnerton. Kaiser's (1945) Wallace Ledge Formation is equivalent to Swinnerton's Wallace Slate; therefore, his Mettawee Slate is nearly synonymous with Swinnerton's Bull Slate. Kaiser, however, did not maintain the Wallace Ledge-Mettawee distinction throughout his map area, and hence the comparison is not completely sustainable. Furthermore, Swinnerton's Bull overlies and is separated from his Wallace (=Keith's Hubbardton) by the Barker Quartzite, whereas Kaiser's Mettawee is supposedly below his Wallace Ledge and is separated therefrom by the Schodack Formation and the Eddy Hill Grit.

BURDEN CONGLOMERATE

(Grabau, 1903, p. 1034)

Burden Iron Ore (=Burden Conglomerate in part), Ruedemann, 1942a, p. 43.
Burden Iron Ore Formation, Goldring, 1943, p. 66.
Claverack Conglomerate+Burden Conglomerate s. s., Chadwick, 1946, p. 585.
Burden Iron Ore (=Burden Conglomerate in part), Fisher, 1956, p. 331.

Type locality.—Burden Iron Mine, town of Livingston, N.Y. (Catskill 15-minute quadrangle, New York).

Original description.—"A calcareous conglomerate in which the pebbles are chiefly limestone embedded in a silicious sand, which in turn is held together by a more or less calcareous cement. The limestone of the pebbles is in part a gray, compact rock (calcilutite) * * * and in part a more granular mass (calcarenite). The matrix is generally stained with iron hydrate."

Age.—Originally called "Champlainic" (=Middle Ordovician); the writer believe that the rock will prove to be late Cambrian to Early Ordovician by lithic comparison with the Germantown Formation, which spans this age range.

Remarks.—Ruedemann (1942a, p. 77) recognized that Grabau's Burden Conglomerate includes at least two units of different ages. Chadwick (1946) proposed the name Claverack Conglomerate for the younger unit, reserving the name Burden Conglomerate for the older, which is the Burden Iron Ore of Ruedemann (1942a). See discussions under "Burden Iron Ore" and under "Germantown Formation."

BURDEN IRON ORE

(Ruedemann, 1942a. p. 43)

Burden Conglomerate (in part), Grabau, 1903, p. 1034.
Burden Iron Ore Formation, Goldring, 1943, p. 66.
Burden Conglomerate, Chadwick, 1946, p. 585.
Zion Hill Quartzite, Fisher, 1956, p. 331.

Type locality.—Burden Mine, at Mount Tom, town of Livingston, N.Y. (Catskill 15-minute quadrangle, New York).

Original description.—"Limonite and siderite iron ore * * * associated with conglomerate with calcareous matrix, full of rounded quartz grains."

Age.—Ruedemann assigned an Early Cambrian age to the rock. The rock, however, is now considered by fieldworkers to be within the lower part of the Germantown Formation; it is also lithically equivalent with the Eagle Bridge Quartzite or the quartzite beds of the Hatch Hill Formation. The unit, therefore, is probably Late Cambrian in age.

Remarks.—In 1931 Ruedemann discussed the iron ores of Burden, N.Y., but did not give the rocks a stratigraphic name. Ruedemann (1931, p. 136) inferred that the rocks are "no doubt of the Normanskill (Chazy) age" because Normanskill graptolites were found in nearby outcrops. However, Ruedemann (1942a) suggested that the Burden Iron Ore is stratigraphically between the Nassau and Schodack Beds and is, therefore, Early Cambrian. This stratigraphic position is now open to debate because of the uncertain status of the associated Schodack; in any event, Ruedemann's (1942a) Schodack is now known to include beds as young as the Early Ordovician (see Craddock, 1957, p. 683). Fisher (1956, p. 330) suggested that the Burden Iron Ore is a residual soil zone on the Lower Cambrian surface, the break marking Middle Cambrian and Late Cambrian times. In his discussion, Fisher used the rock name Zion Hill, because of the then prevailing misconception on the nature and position of the Zion Hill Quartzite (see discussion under that name). In terms of stratigraphic terminology used today, the break proposed by Fisher corresponds to the base of the Upper Cambrian Hatch Hill Formation (Theokritoff, 1959a, p. 55) of the northern Taconic region, or the Eagle Bridge Quartzite of the central Taconic area (Prindle and Knopf, 1932, p. 277; Potter, 1959, p. 1658). Indeed, Zen (in press) from local data suggested that the Hatch Hill Formation may rest unconformably upon Lower Cambrian rocks, and D. B. Potter (written communication, 1961), found a similar relation at the base of the Eagle Bridge. D. W. Fisher (written communication, 1961) suggested elsewhere, however, that the Burden Iron Ore is within or at the top of his Germantown Forma-

tion. If so, and if there is no bedding-plane thrust at the base of the iron ore strata, the iron-stained, green slate underlying the Burden Iron Ore, called the Nassau by Ruedemann (1942a, p. 45) and Fisher (1956, p. 330), and typical thereof, must be assigned to the lower part of the Germantown as an anomalous rock type. The solution of this puzzle may lie in the fact that Ruedemann (1942a, p. 45, 49) specifically distinguished the iron ore beds from the calcareous quartzite beds (quartzitic limestone of Ruedemann) higher in the section, which D. W. Fisher (written communication, 1961) included in the Burden. It is suggested here that the iron ore beds do occur at the base of the Germantown Formation as a regolith on top of the Lower Cambrian rocks as proposed by Fisher but that the calcareous quartzite occurs at several levels within the formation.

CLAVERACK CONGLOMERATE

(Chadwick, 1946, p. 585)

Burden Conglomerate (in part), Grabau, 1903, p. 1034.
Conglomerate in Schodack Beds, Ruedemann, 1942a, p. 67.
Zion Hill Quartzite Member (Ferruginous Quartzite) of the Schodack Formation, Ruedemann, 1942a, p. 66.

Type locality.—Ham's Mills, town of Claverack, N.Y. (Catskill 15-minute quadrangle, New York).

Original description.—"A coarse conglomerate * * * that contains numerous ferruginous quartzite pebbles and other limestone pebbles, * * * incorporated in greenish gray siliceous slates with numerous black worm tubes" (Ruedemann, 1942a, p. 67).

Age.—Designated by Chadwick as Early Cambrian and possibly Late Cambrian; the rock however probably should be included in the Germantown Formation, and must therefore be given a Late Cambrian to Early Ordovician age.

Remarks.—See discussion under "Germantown Formation."

CURTISS [SIC] MOUNTAIN QUARTZITE

(Fisher, 1961, p. D6)

Units B and D, Dale, 1904, p. 29.
Nassau Beds (in part), Ruedemann, 1930, p. 83.
Curtis Mountain Quartzite (of the Nassau Formation), Bird, 1962a, p. 135.

Type locality.—Curtis Mountain, town of Nassau, N.Y. (Nassau 7½-minute quadrangle, New York).

Original description.—"A conspicuous ridge-making green chloritic quartzite varying from 10–70′ thick."

Age.—Cambrian(?), because it underlies the fossiliferous Early Cambrian Ashley Hill Conglomerate in a conformable section.

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Remarks.—According to Dale (1904, p. 22, 28; fig. 8), two kinds of quartzite form three distinct beds on Curtis Mountain (Dusenbery Ridge). Though Fisher did not specify which of these beds is his Curtiss [sic] Mountain Quartzite, the lower two beds, which are lithically alike, correspond to Fisher's description; the uppermost bed is a calcareous quartzite. These identifications were confirmed by Fisher himself (oral communication, 1961). Bird (1962a, p. 135) included the Curtis Mountain Quartzite in his Nassau Formation; Zen (1961, p. 303) suggested that the quartzite now mapped as the Curtis Mountain is equivalent to the Zion Hill Quartzite of the northern Taconic region.

Balk (1953, p. 831) implied that the lower quartzite beds at Curtis Mountain grade into the graywacke of the Rensselaer Plateau immediately to the east. Fisher (1961, p. D21, stop 13) referred also to a quartzite outcrop in Weaver's Elizaville Shales as the Curtiss [sic] Mountain. This quartzite is much like the Zion Hill or the "Rensselaer Graywacke" of the area around Ashley Hill in Chatham, N.Y. (Craddock, 1957, p. 694), but details are lacking for a firm equation.

DEEPKILL SHALE

(Hartnagel, 1912, p. 34)

Synonymy.—Mostly variant spellings and designations.

Deep kill Beds, Ruedemann, 1902, p. 547.
Beekmantown Shale, Dale, 1904, p. 30.
Deep Kill Shale, Ruedemann, *in* Cushing and Ruedemann, 1914, p. 66.
Deep kill Shale, Ruedemann, 1947, p. 123.
Deepkill Beds, Ruedemann, 1947, p. 118.
Deepkill Shales, Ruedemann, 1947, p. 61.
Deep Kill Formation, Fisher, 1961, p. D22.
Deepkill Formation, Lowman, 1962b, p. 221.

Type locality.—Grant Hollow in the Deep Kill, town of Schaghticoke, N.Y. (Tomhannock 7½-minute quadrangle, New York).

Original description.—See Berry (1962, p. 699–701).

Age.—Early to Early Middle Ordovician (Berry, 1962, p. 709).

Remarks.—There are several variant spellings to the name Deepkill; the one presently adopted is that given in the correlation chart for the Ordovician system by Twenhofel and others (1954). The list given is not exhaustive but represents the forms found in the principal source material dealing with the area around the type locality.

The age and stratigraphic problems related to the Deepkill Shale are numerous and have far-reaching implications in Ordovician correlation, as well as in the interpretation of the Taconic sequence. The problem was recently restudied by Berry (1962), to whose work

the reader should refer. Fisher (1961, p. D9) urged abandonment of the name Deepkill for mapping purposes, because the name has assumed time significance; he proposed the names Germantown and Stuyvesant Falls Formations for two lithostratigraphic units of Late Cambrian to Early Ordovician age, both of which, at various places, have yielded "Deepkill" graptolites.

Within the southern Taconic region, the Claverack Conglomerate and the Elizaville Shales probably also contain strata correlative with, or equivalent to, part of the Deepkill; within the northern Taconic region, Deepkill-equivalent or correlative units would be included under these names: the Poultney Slate (B and C members of Theokritoff), the Mount Hamilton Group, and the Mount Hamilton Formation. The following unfossiliferous but lithically similar units, chiefly within the higher parts of the Taconic Range, may eventually also prove to contain Deepkill-equivalent units: The Mount Anthony Formation, the Brezee Formation, the Greylock Schist (as used in the Taconic Range), the Rowe Schist of the Taconic Range, and the Berkshire Schist.

DIAMOND ROCK QUARTZITE

(Ruedemann, *in* Cushing and Ruedemann, 1914, p. 70)

Unit G, Dale, 1904, p. 15.
Schodack Shale and Limestone (in part), Craddock, 1957, p. 694.

Type locality.—Diamond Rock, Lansingburgh, Troy, N.Y. (Troy North 7½-minute quadrangle).

Original description.—"Granular quartzite and associated calcareous sandstone."

Age.—Early Cambrian.

Remarks.—First described in some detail by Dale (1904, p. 15) as his Unit G of the Rensselaer County succession, this rock was given its present name by Ruedemann. Despite its evident Early Cambrian age shown by the abundant, though fragmentary, fossil record (Walcott, 1912, p. 276, loc. 367b; Fisher, 1956, p. 331), the stratigraphic relation of this unit to other Taconic rocks has been obscure because of the uncertain status of the "Troy Shale," which it underlies.

Fisher (1956, p. 331), in considering the correlation of the Diamond Rock with rocks of the northern Taconic region, stated that "whether the Diamond Rock is the correlative of the Eddy Hill Grit is purely conjectural." At that time (1956) the stratigraphic relation of neither unit was clear. We now know that the Eddy Hill is a variant of the Mudd Pond Quartzite, which is a member near the top of the Bull Formation of Zen (1961). Stratigraphic relations at Diamond Rock remains unclear because the outcrop is isolated; however, south of the

type locality, Elam (1960, p. 39) described a bulldozed outcrop "between the Frear Park Golf Course and the Dunn Garden Apartments in Troy" where a peculiar "boulder conglomerate" was found. The writer and J. M. Bird, in August 1961, jointly studied this outcrop. The boulders are broken up beds of a slightly calcareous quartzite, identical with the Diamond Rock Quartzite, and similarly embedded in a matrix of gray-black silty shale. The shale is bordered on the east side of the outcrop by a limestone-pebble conglomerate, the pebbles bearing Lower Cambrian fossils in abundance much like the brecciolas described by Elam from the Rensselaer Polytechnic Institute campus (1960). The field relations confirm a Diamond Rock-Mudd Pond equation on the basis of lithology and stratigraphic sequence. The relations were confirmed by J. M. Bird's observations at Diamond Rock itself (written communication, 1961).

Dale (1904) apparently was the first to suggest that his Unit G in the vicinity of Ashley Hill, in Chatham, N.Y., is the same as the Diamond Rock Quartzite. Craddock (1957, p. 695) suggested that the quartzite below the fossiliferous limestone-pebble conglomerate at Ashley Hill (Ashley Hill Conglomerate) is the same as the Diamond Rock. This suggestion agrees with recent findings outlined above. Craddock (1957, p. 694), however, also assigned the quartzite at Ashley Hill, Dale's Unit G, to the "Schodack shale and limestone," contrary to the usage of Ruedemann (*in* Cushing and Ruedemann, 1914, p. 70).

EAGLE BRIDGE QUARTZITE

(Prindle, and Knopf, 1932, p. 277)

Zion Hill Quartzite, Fisher, 1956, p. 345.
Zion Hill Quartzite, Lochman, 1956, p. 1336.

Type locality.—On Hoosic River in the vicinity of the village of Eagle Bridge, town of Hoosick, N.Y. (Eagle Bridge 7½-minute quadrangle, New York).

Original description.—"A compact, granular sandstone, in places dolomitic, which weathers dark and somewhat rusty. Its thickness ranges from 10 to 30 feet."

Age.—Originally designated as probably Early Cambrian; the rock is probably Late Cambrian to Early Ordovician according to Lochman (1956, p. 1336). Lochman's age assignment accords with the age suggested by lithic comparison with the Late Cambrian Hatch Hill Formation.

Remarks.—Both lithology and stratigraphic sequence indicate beyond reasonable doubt that the Eagle Bridge Quartzite is the same as the quartzite in the Hatch Hill Formation (Theokritoff, 1959a, p. 55) of the northern Taconic region, which is assigned a Late Cam-

brian age on the basis of its graptolite fauna (Berry, 1959, p. 61). Such an age is consistent with the Late Cambrian-Early Ordovician age suggested by Lochman (1956, p. 1336) for the Eagle Bridge on the basis of echinoderm stems found by Bonham. Until recently, however, there has been considerable confusion in the literature on the identity and correlation of the Eagle Bridge, owing to several causes:

1. Confusion of Dale's meaning of the "Ferruginous Quartzite" in his 1899 report. Dale discussed two rock types under this name. The dominant type is now known as the Zion Hill Quartzite, of Early Cambrian age. The second type is apparently of the Eagle Bridge lithology. Dale's error in stratigraphic assignment is due to an incorrect interpretation of the structure associated with the Zion Hill Quartzite. Although Dale's mapping (1892; 1899; 1904) leaves the immediate vicinity of Eagle Bridge as No Man's Land, later geologic works made clear the identity of the Eagle Bridge with the second rock type of Dale. These facts, taken together, led to confusion of the Eagle Bridge lithology with the Zion Hill, and prompted the discussion on their correlation by Prindle and Knopf (1932, p. 277) and the assignment by Larrabee (1939, p. 51) of the Zion Hill to the Early Ordovician. Larrabee's view was followed by Fisher (1956), but the error was perceived by Lochman (1956, p. 1336). Lochman, however, continued to use the incorrect names.
2. The lack of an easily mappable boundary between the Eagle Bridge Quartzite and associated black slate (or, for that matter, the Hatch Hill Formation), on one hand, and the underlying Lower Cambrian black slate on the other. The result is much uncertainty in correlation of units in the absence of fossils.
3. Gross errors in field identification of lithologies. Confusion of the Zion Hill with the Eagle Bridge has already been discussed. Goldring (1943, p. 57, 61) described certain interbedded black slate, limestone conglomerate, and brown-weathering calcareous quartzite units at Nutten Hook and at Judson Point, in the Coxsackie quadrangle, New York, as illustrative of her "Nassau Beds," although these rocks do not correspond to any description of the Nassau lithology. At Nutten Hook, W. B. N. Berry's report of the Upper Cambrian *Dendrograptus* (written communication, 1962) confirms the correlation of these strata with the Hatch Hill and the Eagle Bridge.

Stratigraphic names that have been used for rocks probably, though not demonstrably, equivalent to the Eagle Bridge elsewhere in the Taconic region are as follows:

Northern Taconic region

Ferruginous Quartzite (in part), Dale, 1899, p. 183.
Zion Hill Quartzite, Larrabee, 1939, p. 47.
Zion Hill Quartzite, Fowler, 1950, p. 53.
Zion Hill Quartzite, Billings and others, 1952, p. 36.
Hatch Hill Formation, Theokritoff, 1959a, p. 55.
Poultney River Group, Unit 4, Zen, 1959, p. 2.
Mt. Hamilton Group, Unit 5, Zen, 1961, p. 306.

Southern Taconic region

Schodack Formation (in part)+Burden Iron Ore, Ruedemann, 1942a, p. 43, 62.
Schodack Formation (in part)+Nassau Beds (in part)+Burden Iron Ore Formation, Goldring, 1943, p. 56, 64, 66.
Burden Iron Ore, Fisher, 1956, p. 330.
Germantown Formation (in part), Fisher, 1961, p. D9.

EDDY HILL GRIT

(Ruedemann, *in* Cushing and Ruedemann, 1914, p. 67–70)

Black Patch Grit (Unit C; in part), Dale, 1899, p. 181.
Mudd Pond Quartzite, Zen, 1961, p. 303.

Type locality.—Eddy Hill, town of Fair Haven, Vt. (650 foot knob just southeast of the corner of the village. See Zen, 1961, p. 303, footnote 4) Thorn Hill 7½-minute quadrangle, New York-Vermont.

Original description.—"A grayish grit (graywacke) or sandstone * * * it is also usually characterized by black shaly patches. The cement is calcareous and sericitic. At Eddy Hill this rock contains calcareous concretions or nodules of a quartz sandstone with calcareous cement. Black pebbles * * * occur exceptionally in the grit. The horizon is intermittent" (Dale, 1899, p. 181).

Age.—Originally called Early Cambrian. The rock, at the type locality, underlies fossiliferous Early Cambrian beds (North Brittain) and is therefore strictly Cambrian(?) in age.

Remarks.—The name Eddy Hill Grit has been used by Larrabee (1939), Kaiser (1945), Fowler (1950), and Billings and others (1952) for a variety of rocks, which range from dark pebbly quartz conglomerate to calcareous sandstone, now assigned by Zen to different units. The bulk of the Eddy Hill, including the type outcrop, is relegated to the Mudd Pond Quartzite Member of the Bull Formation (Zen, 1961, p. 303); some outcrops called Eddy Hill by Fowler are now mapped as part of the West Castleton Formation (Zen. 1961, p. 305). Indeed, it appears that Dale's Black Patch Grit includes even rocks that are a grayish variety of the Zion Hill Quartzite found near the base of that unit (Dale, 1899, p. 182).

The confusion doubtless stems in part from the fact that for some time knowledge of the type locality of the Eddy Hill was lost and

the nature of the rock came to be uncertainly known. The extensive use of this name outside of the northern Taconic region, either in an approximate time-stratigraphic sense (Fisher, 1956, p. 332; Bird, 1962a, p. 135) or as a lithofacies name, with or without reference to the nature of the rock at the type locality (Lochman, 1956, p. 1339; Potter, 1959, p. 1658), adds further to the confusion. Because the name Eddy Hill is abandoned as a stratigraphic name in the type area, it probably should not be used elsewhere.

EGREMONT LIMESTONE

(Hobbs, 1893, p. 727)

Stockbridge Limestone (in part)+Bellowspipe Limestone, Hobbs, 1897, p. 177.
Berkshire Schist (in part), Emerson, 1917, p. 39.
Berkshire Schist (in part)+Stockbridge Limestone (in part), Dale, 1923, pl. 1, 3.
Everett Schist (in part), Fisher, 1961, p. D3.

Type locality.—Town of Egremont, Mass. (Egremont 7½-minute quadrangle, Massachusetts-New York).

Original description.—"[The Egremont Limestone] as developed in the valley * * * is a white to gray crystalline limestone, * * * locally it contains thin quartzitic or schistose layers. * * * As met with in the summit plains, the limestone appears under two [intergradational modifications:] 1) a very micaceous limestone or calcareous mica schist, 2) a graphitic schist, often, though not always, calcareous."

Age.—Hobbs (1893) called the Egremont Limestone Ordovician. In the restricted sense of Hobbs (1897), however, the rock may be Cambrian(?) in age, if it is equated to the Bellowspipe Limestone through lithic and stratigraphic comparison.

Remarks.—Hobbs (1893, p. 725) correlated the Egremont with the Bellows Pipe [sic] Limestone. Later (1897) Hobbs realized that the bulk of his Egremont is part of the underlying Stockbridge Limestone (=Canaan Limestone, Hobbs, 1893, p. 726) and accordingly restricted the Egremont Limestone to "the calcareous schist and limestone of the summit plain of Mount Washington" (1897, p. 177); he then substituted for Egremont the name Bellowspipe.

An isolated area of thin-bedded to schistose limestone east of Washburn Mountain in Copake, N.Y. (Copake 7½-minute quadrangle) was mapped as the Upper Cambrian Pine Plains Formation and basal limestone of the Trenton black slate by Weaver (1957, pl. 1). The rock is unfossiliferous but lithically resembles the Bellowspipe Limestone; it may eventually prove to be part of the Egremont Limestone in the restricted sense of Hobbs (1897; Zen, unpublished data).

ELIZAVILLE SHALES

(Weaver, 1957, p. 739)

Nassau Beds, Ruedemann, 1942a, p. 38.
Green slate terrane, Craddock, 1957, p. 691.
Elizaville Shale, Fisher, 1961, p. D5.

Type locality.—Elizaville, town of Gallatin, N.Y. (Catskill 15-minute quadrangle, New York).

Original description.—"Light gray [shales], but range from a light-greenish gray to a dark gray approaching black. It has a rather coarse shaly or fine silty texture, but there are all variations from fine phyllitic shale to coarse siltstone. * * * In the upper part [the unit] contains a horizon with many bands of brown quartzite ranging from 3 inches to 12 inches in thickness, at intervals of 2 or 3 feet. * * * In a fresh exposure, the shale is in places laminated in bands of slightly darker and slightly lighter gray material; the bands are a few millimeters thick."

Age.—Called Late Cambrian to Early Ordovician by Weaver. The rock, however, is a heterogeneous unit, in which lithic types characteristic of the Early Cambrian are well represented (Fisher, 1961, p. D6). The writer also noted, in the area of the Elizaville, rocks reminiscent of the Early to Middle Ordovician Poultney Slate. An age of Early Cambrian to Middle Ordovician is here suggested.

Remarks.—The principal age evidence for the Elizaville Shales unit was a cast of a possible graptolite, *Hologroptus*(?) (Weaver, 1957, p. 740). Inasmuch as the identity of this material is problematic, the age of the rock unit remains unestablished. The supposed fossil specimen now seems to be lost (Weaver, written communication, 1961; J. C. Haff, written communication, 1962).

The type locality of the Elizaville Shales is in the Catskill quadrangle, in a belt of rocks continuous with the Elizaville in the Copake quadrangle. Ruedemann (1942a) showed the type area as underlain by the Lower Cambrian Nassau Beds. Fisher (1961, p. D6, D21, stop 13) hinted at an Early Cambrian age for at least part of the Elizaville and equated the rock with the Mettawee Slate. The writer (unpublished data) found considerable variation in rock type within Weaver's Elizaville; some rock types are reminiscent of Ordovician units elsewhere in the Taconic region. Further work is needed.

EVERETT SCHIST

(Hobbs, 1893, p. 725)

Berkshire Schist, Hobbs, 1897, p. 177.
Berkshire Schist, Gregory and Robinson, 1907, p. 33.
Berkshire Schist, Emerson, 1917, p. 39.

Salisbury Schist, Agar, 1932, p. 38.
Berkshire Schist, Weaver, 1957, p. 746.
Salisbury Schist, Rodgers and others, 1959, p. 9.

Type locality.—Mount Everett, town of Mt. Washington, Mass. (Bashbish Falls 7½-minute quadrangle, Mass.-Conn.-New York).

Original description.—"[The rock is] porphyritic from lenticular feldspar grains * * *. The base [of the unit] is generally * * * chloritic or sericitic. Ottrelite is found sparingly * * *. Macroscopic garnet and staurolite [is entirely absent] * * *. The beds seem to become more sericitic along the northwestern foot of [Mount Washington]. A phase of the rock which is more characteristic of the southeastern portions of the area is very chloritic with magnetite octahedra sometimes as large [as] a pea. Chloritic phases of the rock also appear in the extreme northern areas."

Age.—Assigned by Hobbs (1893) to the Ordovician, the rock may prove to be Cambrian(?) in age by lithic comparison with the Cambrian(?) Biddie Knob Formation and the Early Cambrian and Cambrian(?) Bull, St. Catherine, and Nassau Formations.

Remarks.—The stratigraphic and structural relations of the Everett Schist are obscure and hitherto have not been studied in detail. The rock was called the Berkshire Schist by Gregory and Robinson (1907), Emerson (1917), and Weaver (1957), presumably in the expanded sense of that name, as discussed under Berkshire Schist, p. 18. Lithically, the rock is similar to the Rowe Schist (in the Taconic Range) of Prindle and Knopf (1932, p. 289), the Austerlitz Phyllite of Fisher (1961, p. D5), the Mount Anthony Formation of MacFadyen (1956, p. 28), part of the Mount Anthony Formation of Hewitt (1961b, p. 32), part of the St. Catherine Formation of Doll and others (1961), the "Greylock Schist" of Thompson (1959, p. 77), the Biddie Knob Formation and part of the Bull Formation of Zen (1961, p. 299, 300), and the Greylock Schist on Mount Greylock (Dale, 1891), with which Hobbs originally correlated the Everett. None of these rocks can presently be firmly correlated with the Everett Schist because the Everett forms an isolated mass of green schist. Hobbs' original correlation of the Everett with the Greylock, however, remains the most reasonable.

The Canaan Limestone, the Riga Schist, the Egremont Limestone, and the Everett Schist, were collectively called by Hobbs (1893, p. 725) the "Mount Washington Series," a name of little usefulness today.

FORBES HILL CONGLOMERATE (IN THE HORTONVILLE SLATE)

(Zen, 1961, p. 311)

Synonymy.—None.

Type locality.—East of the gravel road due east of Forbes Hill, town of West Haven, Vt. (Benson 7½-minute quadrangle, Vermont-New York).

Original description.—"A black slate [enclosing] boulders of black quartzite similar to the Mudd Pond, up to 4 feet across; other pebbles are of the Bomoseen greywacke type, a dolomitic quartzite, up to 6 inches across, and innumerable angular green slate chips and sandstone chips less than 1 inch across."

Age.—Middle Ordovician.

Remarks.—Although no fossil has been found to date in the conglomerate, the black slate of the matrix is part of the autochthonous Hortonville Slate, which in this area is post-Glens Falls and, therefore, post-early Sherman Fall in age.

In the Hoosick Falls area, New York, a rock similar to the Forbes Hill was found by D. B. Potter (written communication, 1962) to overlie a black slate that carried graptolites belonging to the *Climacograptus bicornis* fauna; Potter mapped it as part of the Hortonville-correlative (and equivalent) Walloomsac Slate. The Forbes Hill is also lithically similar to the Rysedorph Conglomerate, which occupies the same tectonic position relative to the Taconic rocks as does the Forbes Hill, and is Trenton in age (Ruedemann, 1901b); the two rocks probably will prove to be correlative units.

GERMANTOWN FORMATION

(Fisher, 1961, p. D9)

Burden Conglomerate (in part), Grabau, 1903, p. 1034.
Burden Iron Ore+Schodack Limestone and Shale (in part)+Zion Hill Quartzite Member of the Schodack Formation, Ruedemann, 1942a, p. 43, 64, 66.
Burden Iron Ore Formation+Schodack Limestone and Shale (in part), Goldring, 1943, p. 66, 68.
Claverack Conglomerate+other units, Chadwick, 1946, p. 585.
Burden Iron Ore+other units, Fisher, 1956, p. 330.
Deepkill Shale, Craddock, 1957, p. 683.

Type locality.—Fisher's Quarry 2½ miles southeast of Germantown, and nearby road cut on Columbia County Route 8 (road from Germantown to Bingham Mills), town of Germantown, N.Y. (Catskill 15-minute quadrangle, New York).

Original description.—"Interbedded black shales and thin calcilutites, limestone brecciolas, thin laminated siltstones and calcareous and ferruginous sandstones."

Age.—Late Cambrian to Early Ordovician.

Remarks.—Two representative localities for the Germantown Formation were specified by Fisher (1961, p. D21, stops 14 and 18). Stop 18 is presumbaly the type locality of the formation. Stop 14 is a road cut on U.S. Highway 9, one-half mile south of Becraft Mountain in Greenport, N.Y. The rocks are not identical at these two places. The assemblage of rocks at stop 18 (Fisher's Quarry) closely resembles the rocks that are called the Hatch Hill Formation and the basal beds of the A-member of the Poultney Slate by Theokritoff (1959a, p. 63, stop 1; written communication, 1960); Unit 5 of the Mount Hamilton Group by Zen (1961, p. 306); the Eagle Bridge Quartzite by Prindle and Knopf (1932, p. 277) and Potter (1959); and incorrectly, the Zion Hill Quartzite by Larrabee (1939, p. 51), Fowler (1950, p. 54), Billings and others (1952, p. 55), Fisher (1956, p. 345), and others: the rocks are black slate, interbedded with rotten-weathering calcareous sandstone and limestone conglomerate in a sandy matrix. At stop 14, on the other hand, the rock is a black slate with thin, even interbedding of gray ribbon limestone, lithically similar to part of the Schaghticoke (Ruedemann, 1903) and the Poultney A-member of Theokritoff (written communication, 1961). Fisher (1961, p. D9) cited the finding in the Germantown Formation of *Callograptus* and *Dendrograptus*, forms also found in the Hatch Hill Formation and considered by Berry (1959, p. 61) to be Upper Cambrian; these fossils are from Fisher's quarry (W. B. N. Berry, written communication, 1962). Fisher (1961, p. D9) avoided correlating the Germantown with the Schaghticoke, however, because the Schaghticoke is considered Early Ordovician in age. Fisher (1961, p. D9) specified that the Germantown is a lithostratigraphic unit; the overlying, sedimentologically continuous but lithically different unit is called the Stuyvesant Falls Formation.

The faunas of Fisher's stop 14 and adjacent outcrops have been discussed by Craddock (1957, p. 684), and more thoroughly described and discussed by Berry (1962, p. 708). Berry's collections show that these outcrops of the Germantown are correlative, in part, with the Hatch Hill Formation of the northern Taconic region, and in part possibly with the lower beds of the Deepkill section, and thus probably the lower parts of the Poultney Slate (A- and B-members of Theokritoff).

The Germantown Formation presumably includes the Burden Iron Ore which Fisher (1956, p. 331) considered Upper Cambrian. Fisher (written communication, 1961) also suggested that the Claverack Conglomerate (Chadwick, 1946, p. 585) be assigned to the top of the Germantown, in accord with the age suggested by Chadwick.

According to Ruedemann (1942a, map), rocks that include the type locality of the Germantown constitute an outlier surrounded on

all sides by the Middle Ordovician Normanskill. The extension of the name Germantown to the main belt of Taconic rocks, therefore, must continue to be a matter of interpretation.

GREENWICH SLATE

(Dale, 1904, p. 43)

Greenwich Formation, Dale, 1904, p. 50.
Nassau Beds+Bomoseen Grit+Diamond Rock Quartzite+Troy Shale+Schodack Shale and Limestone, Ruedemann, 1930, p. 79.
Greenwich Formation+Nassau Beds, Billings and others, 1952, p. 11.
Mettawee Formation, Fisher, 1956, p. 336.
West Castleton Formation+Nassau Formation, Bird, 1962a, p. 135.

Type locality.—Town of Greenwich, N.Y. (Schuylerville 15-minute quadrangle, New York).

Original description.—None given.

Age.—Originally assigned to the Early Cambrian; the rock is probably best called Cambrian(?) and Early Cambrian because it appears to be equivalent to, or possibly identical with, the bulk of the Nassau Formation, or the Bull Formation plus the Biddie Knob Formation.

Remarks.—Dale's original intention for the scope of the Greenwich Slate (or Formation) was not clear. He stated (1904, p. 50) that the entire Rensselaer County succession of Lower Cambrian rocks is "regarded as equivalent to the Greenwich Formation of Washington County, N.Y., and Rutland County, Vt., where * * * the basal part of the formation as exposed in Rensselaer County (horizons A to E) does not appear to be exposed." Billings and others (1952, p. 11) interpreted this statement to mean that the Greenwich is equivalent to the expanded Schodack Formation of Ruedemann and Resser (Ruedemann, 1942a, p. 64), which overlies the Nassau Beds (Units A–E, Dale, 1904) as well as Dale's unit F, which is probably the Bomoseen Greywacke. The expanded Schodack Formation, however, does not include as significant rock types the Cambrian purple and green slates, which predominate in Washington County, N.Y., and Rutland County, Vt. The crux of the matter is Dale's meaning of the word "equivalent." In the chronostratigraphic sense for the entire Early Cambrian (suggested by the table on his p. 43), the Greenwich should be equivalent to the entire Lower Cambrian of Rensselaer County; in the lithostratigraphic sense, the Washington County and Rutland County units more closely resemble the Nassau Beds. Dale was not consistent; a possible alternative interpretation of his intention, implicit in the interpretation of Billings and others, that the Schodack Formation of Resser and Ruedemann is the time-

equivalent of the entire northern Taconic Lower Cambrian succession, cannot be demonstrated uniquely.

Fisher (1956) equated the Greenwich only to the Mettawee Slate (=Formation), and therefore, on the basis of his figure 4 (p. 337), to only part of the "Nassau Shale and Grit." The latter, in its entirety, is Ruedemann's Nassau Beds on the basis of the same figure. Fisher's equation would then lead to the curious result that the Greenwich becomes either part of itself or of the unit that it overlies.

GREYLOCK SCHIST

(Dale, 1891, p. 5)

Rowe Schist (of Mount Greylock)+Hoosac Schist (of Mount Greylock, in part), Prindle and Knopf, 1932, p. 287, 289.
Greylock Schist+Berkshire Schist (in part), Herz, 1958.
Greylock Schist+Berkshire Schist (in part), Herz, 1961.

Type locality.—Mount Greylock, town of Adams, Mass. (Williamstown 7½-minute quadrangle, Massachusetts-Vermont).

Original description.—"Schists resembling in their petrographic character, appearance, and structure those of the Berkshire Schist Formation. If there be any difference between them it consists in that [the Greylock Schist is] more chloritic and albitic, and less frequently calcareous or plumbaginous than [the Berkshire Schist]" (Dale, 1894b, p. 186).

Age.—Called Ordovician by Dale (1891) and reassigned many times, the rock may yet prove to be Cambrian(?) in age because of its lithic equivalence with the Cambrian(?) Biddie Knob Formation and the Cambrian(?) and Early Cambrian St. Catherine Formation in the Taconic Range to the west, and with the Cambrian(?) Hoosac Formation in the Hoosac Range to the east.

Remarks.—Dale assigned the Greylock Schist to the Ordovician because he believed that it is part of a conformable sequence composed of the Stockbridge Limestone, the Berkshire Schist, the Bellowspipe Limestone, and the Greylock Schist. This conclusion of conformability was rejected by Prindle and Knopf (1932), who assigned the Greylock Schist to their Hoosac and Rowe Schists, of Early Cambrian age; the Greylock-Bellowspipe contact was regarded as a folded thrust fault because the Bellowspipe was thought to be part of the Lower Ordovician Stockbridge Limestone. Herz (1958; 1961) reverted to Dale's interpretation of the structure of Mount Greylock; his Greylock Schist, however, is more restricted than Dale's, because the grayish schists above Dale's Bellowspipe Limestone was assigned by Herz to the upper part of the Berkshire Schist instead of to the lower part of the Greylock Schist. Herz designated the age of the Greylock

as Middle Ordovician. As the age designation of this unit so far depends entirely on correlation, it is subject to major changes.

Hobbs (1893, p. 725) correlated his Everett Schist with the Greylock. Later (1897, p. 177) he assigned the Everett to the Berkshire Schist and thus, by implication, abandoned the earlier correlation; this early correlation may nevertheless be largely valid. Other rock units that lithically resemble the Greylock and occupy comparable structural and stratigraphic positions, but for which a correlation is currently impossible, are: the Mount Anthony Formation of MacFadyen (1956) and of Hewitt (1961b, in part), the "Rowe Schist in the Taconic Range" (Prindle and Knopf, 1932, p. 289), the Greylock Schist of Thompson (1959, p. 77), part of the "Berkshire Schist" of Dale (1912), part of the St. Catherine Formation (Doll and others, 1961), the Biddie Knob Formation (Zen, 1961), the Austerlitz Phyllite (Fisher, 1961), and part of the Berkshire Schist of Weaver (1957).

HATCH HILL FORMATION

(Theokritoff, 1959a, p. 55)

Ferruginous Quartzite and Sandstone (Unit E; in part), Dale, 1899, p. 183.
Zion Hill Quartzite, Larrabee, 1939, p. 51.
Zion Hill Quartzite (in part), Fowler, 1950, p. 53.
Zion Hill Quartzite (in part), Billings and others, 1952, p. 55.
Zion Hill Quartzite (in part), Fisher, 1956, p. 331.
Unit 4 of the Poultney River Group, Zen, 1959, p. 2.
Unit 5 of the Mount Hamilton Group, Zen, 1961, p. 306.
Hatch Hill Shale, Berry, 1962, p. 699.

Type locality.—Stream valley on the south side of Hatch Hill, town of Whitehall, N.Y. (Thorn Hill 7½-minute quadrangle, New York-Vermont) (Theokritoff, written communication, 1962; the type locality has been changed).

Original description.—"Sooty black pyritic rusty-weathering shales interbedded with rotten-weathering bluish dolomitic sandstones, locally cross bedded, and characteristically traversed by numerous quartz veins."

Age.—Late Cambrian.

Remarks.—The lithostratigraphic unit called the Hatch Hill Formation was for a long time confused by Taconic workers with the rock now called the Zion Hill Quartzite and Greywacke Member of the Bull Formation (Zen, 1961, p. 302). Both units were called the Zion Hill by Larrabee, Fowler, Billings and others, and Fisher, in the works cited. Dale (1899, p. 184) first lumped these two distinct rocks together; the error stemmed from two sources: (1) Dale's incorrect stratigraphic sequence involving his "Ferruginous Quartzite," which is in part the Zion Hill but which Dale placed above his "Cambrian

Black Shale" (=West Castleton Formation, Zen, 1961, p. 304) because he overlooked an important thrust fault, the Pine Pond Thrust Fault of Zen (1961, p. 314), and (2) Dale's explicit correlation, therefore, of the Zion Hill-type green quartzite with the Hatch Hill-type black quartzite. Later workers also fail to agree on the meaning of Dale's "Ferruginous Quartzite"; the modifier is variously interpreted to refer to the limonite-spotted green colour of the Zion Hill or to the limonitic-weathering iron-bearing calcite cement of the Hatch Hill.

The confusion is now clarified, on one hand, by the elucidation of the stratigraphic positions of the two quartzites, and, on the other, by the finding of *Callograptus*, *Dendrograptus*, and *Dictyonema* in the black slates within the Hatch Hill by Theokritoff (1959a, p. 55), which establishes the age of the Hatch Hill as Late Cambrian. Similar rocks elsewhere in the Taconic region—for instance at Nutten Hook in the Coxsackie quadrangle (Hudson North 7½-minute quadrangle), New York (Goldring, 1943, p. 57), have also yielded these graptolites (W. B. N. Berry, written communication, 1962); the regional continuity of this lithostratigraphic and possibly chronostratigraphic unit is demonstrated. The Eagle Bridge Quartzite of Prindle and Knopf (1932, p. 277) is indubitably the Hatch Hill-equivalent; Lochman (1956, p. 1340) indicates that the Eagle Bridge could be Late Cambrian.

The Burden Iron Ore (Ruedemann, 1942a, p. 330) and parts of the Germantown Formation (Fisher, 1961, p. D9) are also to be equated with the Hatch Hill.

HOOKER SLATE

(Swinnerton, 1922, p. 74; Keith, 1932, p. 402)

Hooker Formation, Zen, 1956, p. 1830.
West Castleton Formation, Zen, 1961, p. 304.
See section on "West Castleton Formation" for further synonymy.

Type locality.—Hooker Hill, town of Castleton, Vt. (Bomoseen 7½-minute quadrangle, Vermont).

Original description.—"A notably black slate" (Keith, 1932, p. 402).

Age.—Early Cambrian.

Remarks.—Although Swinnerton first named the rock unit, its first publication is due to Keith (1932, p. 402). The name is abandoned by Zen (1961) because at the type locality the rock is unfossiliferous, is in part lithically similar to the much younger Poultney Slate, and is so complicated by extreme deformation that no simple stratigraphic section can be demonstrated.

HORTONVILLE SLATE

(Keith, 1932, p. 369)

Benson Slate+"Ordovician Slate" (="Lower Silurian Slate"), Dale, 1899, pl. 13 (name Benson is not included in Wilmarth, 1938).
Canajoharie Shale, Kay, 1937, p. 265, 268.
Shale of the Trenton Formation, Rodgers, 1937, p. 1579.
Hortonville Formation, Billings and others, 1952, p. 38.
Hortonville Formation, Zen, 1959, p. 3.
Hortonville Formation, Doll and others, 1961.

Type locality.—Hortonville, towns of Hubbardton, Sudbury, and Orwell, Vt. (Bomoseen 7½-minute quadrangle, Vermont).

Original description.—"Red-brown weathering, locally quartzitic, blue-black slate" (Cady, 1945, p. 558). Rock is poorly described by Keith (1932).

Age.—Middle Ordovician (Keith, 1932); Trenton (Sherman Fall) (Cady, 1945, p. 522).

Remarks.—Keith's name, Hortonville Slate, for the black, dark-gray, and blue-gray fissile to silty shale and slate immediately underlying the Taconic sequence in the vicinity of Hortonville, Vt., has been widely accepted. Keith (1932, p. 369) indicated a correlation of this rock unit with the Middle Ordovician Snake Hill Shales, and Kay (1937, p. 272) correlated the Snake Hill with the Canajoharie Shale. Kay (1959, pl. B–2) used the name Hortonville Slate for the black slate around Hortonville village.

Although Keith reported the Hortonville to be unfossiliferous, W. M. Cady (oral communication, 1961) found *Praesopora* in limestone interbedded in the basal beds of the Hortonville near Johnson Pond, in Sudbury, Vt., and Kay (1959, p. 18) described localities nearby where brachiopods are found within the slate beds. Zen (in press) reported on these fossils, which were identified by G. A. Cooper. The upper part of the formation, however, so far has yielded no fossils; the numerous reports of graptolites (Dale, 1899) from this rock can not be substantiated by new findings, and the old fossils, never identified as to genus, have been lost (Zen, 1961, p. 312).

Since 1945, the name Hortonville Slate (or Formation) has been extended to similar rocks east of the Taconic sequence (Fowler, 1950, p. 34; Billings and others, 1952, p. 38; Brace, 1953, p. 39; Doll and others, 1961). As does the Hortonville Slate at the type locality, this eastern belt of black phyllite unconformably overlies Lower Ordovician carbonate rocks; limestone in the lower part of the phyllite (Whipple Marble, Fowler, 1950, p. 32; Thompson, 1959, p. 81; Zen, 1961, p. 309; also in press) has yielded Trenton fossils. The phyllite has been correlated with the Middle Ordovician Walloomsac Slate in the Bennington, Vt., area (MacFayden, 1956, p. 28), which is on

strike to the south. Zen (1959, p. 3) suggested that, for the eastern belt of the phyllite, Keith's name Ira be revived with emendations, because this belt of rocks cannot be traced into the type Hortonville. The name Ira Formation was used by Zen (1961, p. 310) to include Fowler's Whipple Marble as a member.

HUBBARDTON SLATE

(Keith, 1932, p. 401)

Cambrian Roofing Slate (in part)+Berkshire Schist (in part), Dale, 1899, p. 180, 191.
Wallace Slate, Swinnerton, 1922, p. 63.
Mettawee Slate (in part)+Wallace Ledge Formation, Kaiser, 1945, p. 1085, 1089.
Mettawee Slate (in part), Fowler, 1950, p. 47.
Mettawee Slate Facies (of the Bull Formation) (in part)+Biddie Knob Formation (in part), Zen, 1961, p. 299, 300.
St. Catherine Formation (in part), Doll and others, 1961.

Type locality.—Hubbardton village, town of Hubbardton, Vt. (Bomoseen 7½-minute quadrangle, Vermont).

Original description.—"Mainly green slate with a variable amount of the purple slate."

Age.—Called Early Cambrian by Keith. The rock underlies Lower Cambrian rocks in a conformable sequence, and therefore should be designated Cambrian(?).

Remarks.—The Hubbardton Slate is now mapped by Zen as parts of the Bull and Biddie Knob Formations. See discussions of these names for further information.

INDIAN RIVER SLATE

(Keith, 1932, p. 403)

Hudson Red and Green Slate (Unit Irs), Dale, 1899, p. 189.
Normanskill Red Slate, Larrabee, 1939, p. 51.
Normanskill Formation (in part), Fowler, 1950, p. 55.
Indian River Formation, Theokritoff, 1959a, p. 56.
Unit 5, Poultney River Group, Zen, 1959, p. 2.
Unit 4, Mount Hamilton Group, Zen, 1961, p. 306.
Mount Hamilton Formation (in part), Doll and others, 1961.

Type locality.—Indian River, south of Granville, N.Y. (Granville 7½-minute quadrangle, New York-Vermont).

Original description.—"Mainly bright red slate with a few seams or layers of fine green quartzite; the latter occur only locally."

Age.—Originally assigned to the Early Ordovician. Recent faunal studies by Berry (1959, table 1) indicate that the age of this rock unit is late Middle Ordovician.

Remarks.—Theokritoff (1959a, p. 56) amplified Keith's original description of the Indian River Slate to include the bluish-green slate

commonly found intimately associated with the red slate in northern Washington County, N.Y. Although some red-purple slate, which resemble the Indian River, occur as local lenses within the underlying Poultney Slate (Zen, 1961, p. 306), the Indian River is on the whole a distinct rock unit, easily mapped in the field, and, by lithic and stratigraphic comparison, followed from one area to another throughout the Taconic belt.

Mapping by Craddock (1957), Potter (1959), A. S. Warthin (oral communication, 1959), Elam (1960), Platt (1960), and Berry (1962) in areas of the Taconic region south of the latitude of the type locality near Granville, N.Y., shows that the Indian River lithology is persistent and that it occurs at the base of a distinctive rock section, the "Normanskill terrane" of Craddock (1957, p. 687). Craddock called the basal red shale the "red shale unit," and the overlying unit, consisting dominantly of red and black chert and black shale, the "Mount Merino unit." Fisher (1961, p. D9) specifically correlated the red shale unit, which is basal to his "Normanskill Group," with the Indian River; he called the overlying unit the Mount Merino Black Shale and Chert. Berry (1962, p. 711) subdivided Ruedemann's (1942a) Mount Merino into three members, which he called the (3) white-weathering black and green chert and interbedded black and green siliceous argillite, (2) gray mudstone and black shale, and (1) red and green chert and shale. Berry's members (3) and (2) are Craddock's "Mount Merino unit" or Fisher's "Mount Merino Black Shale and Chert"; his member (1) is Craddock's "red shale unit." This latter unit is similar to the Indian River Slate of the northern Taconic region (as first pointed out by Craddock, 1957, p. 687), and has been so identified by Berry (1962, p. 711); however, Berry's description, "waxy appearance and weather white," suggests that he included some of the reddish beds classified by Zen (1961, p. 306) as Unit 3 in the Mount Hamilton Group or (Zen, in press) as part of the upper Poultney Slate.

Rocks included in members (3) and (2) by Berry, or "Mount Merino" by Fisher and Craddock, are, as a whole, absent in the area around the type locality of the Indian River and farther north in western Vermont. The difference may be due to sedimentary thinning of the units to the north, as suggested by Berry (1962, p. 712), or may be due to a lateral facies change. The presence of a regional unconformity at the base of the Pawlet Formation (=Austin Glen Member of the Normanskill) in the northern Taconic region, however, suggests that erosion of these higher strata cannot be ruled out as an explanation.

Although commonly considered as part of the Taconic sequence, the Indian River Slate, or its equivalent, may not be entirely alloch-

thonous. In the Poughkeepsie and Rhinebeck quadrangles, New York, A. S. Warthin (oral communication, 1959), found that these red shale and slate rest conformably above the Balmville Limestone Member of the Wappinger Limestone (Holzwasser, 1926, p. 40), which in turn is unconformable above the Lower Ordovician parts of the Wappinger Limestone. Warthin also found that the Lower Normanskill beds, which include the Indian River-equivalent, interfinger with typical Snake Hill beds of unquestioned autochthonous origin. A possible explanation of the relations has been given by Zen (1960b).

IRA FORMATION

(Zen, 1961, p. 310)

Berkshire Schist (Unit Sb; in part), Dale, 1899, p. 191.
Berkshire Schist (in part)+Ordovician Marble (in part), Dale, 1912, p. 66.
Ira Slate+West Rutland Marble (in part), Keith, 1932, p. 398, 399.
Canajoharie Phyllite+True Blue Marble (in part), Bain, 1938, p. 7.
Hortonville Slate+Whipple Marble, Fowler, 1950, p. 32, 34.
Hortonville Formation+Whipple Marble, Billings and others, 1952, p. 38.
Canajoharie Phyllite+True Blue Marble (in part), Bain, 1959, p. 36.
Hortonville Formation+Glens Falls, Orwell, and Middlebury Limestones, Doll and others, 1961.

Type locality.—Ira village, town of Ira, Vt. (Castleton 15-minute quadrangle, Vermont-New York).

Original description.—"The rocks are black to dark grey, micaceous to silty, and weather dull to rusty due to pyrite. Bedding is commonly absent in this rock; where visible, it is due to 1) interbedded quartzite a few inches thick; 2) rusty, porous-weathering limy bands, or 3) thin (½ mm or less) white sandy laminae * * *. Locally, orange-weathering dark dolomitic beds, up to 6 feet thick occur * * * another important rock type is a dark grey to jet black phyllite with albite porphyroblasts less than ½ mm across, interbedded with black or grey non-albitic phyllite" (Zen, in press).

"[The Whipple Marble Member is] dark grey, fine-grained, and commonly thin-bedded; locally * * * [it has] black phyllitic partings or brown-weathering thin dolomitic layers. * * * [The] rocks occur either at the base of, or interbedded with, the basal strata of the black phyllite" (Zen, 1961, p. 309).

Age.—Trenton (Zen, in press).

Remarks.—The name Ira Formation is an extension of Keith's name Ira Slate. The extended meaning of the name includes the limestone unit that Fowler called the Whipple Marble (1950, p. 32). The Whipple is designated by Zen as a member of the Ira Formation. The slate of the Ira Formation is equivalent to and probably correlative with the Hortonville Slate west of the Taconic sequence; the basal

beds of the Hortonville are also interbedded with limestone strata (Cady, 1945, p. 559); these limestone beds, as well as at least part of the underlying Middle Ordovician limestone units (designated the Middlebury, Orwell, and Glens Falls by Cady, 1945, p. 552, 556–7) are equivalent to the undifferentiated Whipple Marble (Zen, 1961, p. 309).

The name Ira was used by Thompson (1959, p. 71) in the sense of Zen (1959; 1961). Doll and others (1961) retained Fowler's application of the name Hortonville, calling it a formation, but they show the Whipple as undifferentiated Glens Falls, Orwell, and possibly Middlebury Limestones.

METTAWEE SLATE FACIES (OF THE BULL FORMATION)

(Zen, 1961, p. 300)

Cambrian Roofing Slate (Unit B)+Berkshire Schist (Unit Sb, in part), Dale, 1899, p. 180, 191.

Mettawee Slate, Ruedemann, *in* Cushing and Ruedemann, 1914, p. 69.

Bull Slate+Wallace Slate (in part)+Stiles Phyllite (in part), Swinnerton, 1922, p. 63, 69, map.

Bull Slate+Hubbardton Slate (in part)+Stiles Phyllite (in part), Keith, 1932, p. 400, 401.

Mettawee Slate+Rowe Schist, Larrabee, 1939, p. 48, 50.

Mettawee Slate+Wallace Ledge Formation (in part), Kaiser, 1945, p. 1085, 1089.

Mettawee Slate+Nassau Formation (in part), Fowler, 1950, p. 38, 47.

Mettawee Slate+Nassau Formation (in part), Billings and others, 1952, p. 37.

Mettawee Member (of the Bull Formation), Zen, 1959, p. 1.

Mettawee Member (of the Bull Formation), Theokritoff, 1959b.

St. Catherine Formation (in part), Doll and others, 1961.

Mettawee Slate, Hewitt, 1961b, p. 23.

Type locality.—Mettawee River, in the area of Pawlet, Vt. and Granville, N.Y.

Original description.—(a) A soft, purple and green slate or phyllite; (b) a medium-grained hard phyllite with albite porphyroblasts; (c) a hard, siliceous, poorly cleavable, green to purple mudstone; also included are rusty-weathering, cream-white limestone beds up to 1 foot thick, and thin greenish quartzite layers. (Zen, 1961, p. 300.)

Age.—Called Early Cambrian by Dale and so accepted by most modern workers; the unit, however, includes strata that conformably underlie the lowest fossiliferous Early Cambrian beds known in the section. The proper age assignment is thus Cambrian(?) and Early Cambrian.

Remarks.—The Cambrian Roofing Slate (Unit B) of Dale (1899) is the Mettawee Slate of Ruedemann (*in* Cushing and Ruedemann, 1914), and corresponds to Zen's Mettawee plus the Biddie Knob Formation. Part of Dale's Berkshire Schist in the Taconic Range must also be assigned to the Mettawee.

The Bull Slate of Swinnerton (1922, p. 69) and of Keith (1932) constitutes the part of Zen's Mettawee that occurs above the horizon of the Zion Hill Quartzite and Graywacke (Barker Quartzite of Swinnerton and Keith). Similar slate strata below the Zion Hill, called the Wallace Slate by Swinnerton and the Hubbardton Slate by Keith, are partly Zen's Mettawee and partly Zen's Biddie Knob Formation. Zen's Mettawee and Biddie Knob are also equivalent to the Stiles Phyllite of Keith and Swinnerton.

The Mettawee Slate of Larrabee (1939), Kaiser (1945), Fowler (1950), and Billings and others (1952) are nearly synonymous with the Mettawee as used by Zen and by Theokritoff (1959b); Theokritoff, however, included in this unit Zen's North Brittain and Mudd Pond Members of the Bull Formation. Parts of the rocks mapped by Kaiser as the Mettawee (Kaiser's map was largely adopted by Fowler), however, do not fit Kaiser's own lithic definition and must be assigned to other units. Kaiser's Wallace Ledge Formation is in part the Mettawee of Zen, but, like the Wallace Slate of Swinnerton, it is in part the Biddie Knob. Kaiser did not consistently follow his division of the "Roofing Slates" into the Mettawee and Wallace Ledge because he failed to recognize the Zion Hill Quartzite over large areas.

Fowler's Nassau Formation of the southern part of the Castleton quadrangle is in part mapped as the Mettawee by Zen (1961). The bulk of Fowler's Nassau, however, belongs to the Biddie Knob Formation. The limited area of Rowe Schist of Larrabee apparently lies entirely within the area mapped by Zen (1961) as the Mettawee.

Doll and others (1961) abandoned the name Mettawee and referred the rocks to the slate and phyllite units of the St. Catherine Formation. Rocks so designated include the Biddie Knob Formation or its equivalent as a lithofacies, and also include Zen's North Brittain and Mudd Pond Members of the Bull Formation.

The name Mettawee is used in the sense of Theokritoff (1959a, b) by Potter (1959) around Hoosick Falls in the central Taconic region. In so doing, Potter agreed with Prindle and Knopf (1932). In the area just west of the Rensselaer Plateau, Bird (1962a) used the name Mettawee for slates and shales called the Nassau by past workers (Ruedemann, 1930, p. 83; Craddock, 1957, p. 691); Bird designated his Mettawee as a member of an enlarged Nassau Formation. The Nassau is equated by Bird with the Bull of Zen, an equivalence strongly suggested by the work of Dale (1904) and Ruedemann (1930), and made explicit by Fisher (1961, p. D8) and Zen (1961, p. 303). Bird's work, as well as the works of Talmadge (1956), Craddock (1957), and Elam (1960), makes this equation a virtual certainty. The Mettawee of the northern Taconic region, however, includes part

of the Schodack of Columbia and Rensselaer Counties, N.Y., but excludes part of the Nassau Beds of Goldring (1943, p. 56), as has been discussed elsewhere.

It appears that Dale's Units A, C, E, and H (1904), with the possible exception of part of A, which is lithically like the Bomoseen Greywacke, correspond to the Mettawee. Parts of Weaver's (1957, p. 739) Elizaville Shales and of Fisher's (1961, p. D5) Austerlitz Phyllite may prove to be the same when data become available.

MOUNT ANTHONY FORMATION

(MacFadyen, 1956, p. 28)

Berkshire Schist, Dale, 1923, pl. 1.
Rowe Schist (in the Taconic Range), Prindle and Knopf, 1932, p. 289.
St. Catherine Formation, Doll and others, 1961.
Mount Anthony Formation (in part), Hewitt, 1961b, p. 32.

Type locality.—Mount Anthony, town of Bennington, Vt. (Pownal 7½-minute quadrangle, Vermont).

Original description.—"Dominantly an altered argillite and sandy argillite. Occasional limestone and dolomite lenses are present * * *. In color, the rock varies from gray to green, with the green facies most extensive in the upper part of the formation. On the western margin of the [Bennington quadrangle], it is a fine-grained sericite and chlorite schist often containing chloritoid * * *. Going eastward, the formation changes into a chlorite-biotite schist containing many thin sandy laminae. Locally albite is well-developed in the gray facies * * *. Pods or lens-like masses of vein quartz are common."

Age.—Designated as Middle to Late Ordovician by MacFadyen (1956). The rock may be Cambrian(?), however, if it proves to be correlative with the Biddie Knob and Bull Formations of the northern Taconic region, as suggested by Doll and others (1961).

Remarks.—The Mount Anthony Formation was assigned to the Middle or Late Ordovician by MacFadyen (1956, p. 29) because of its apparent gradational contact with the underlying Walloomsac Slate, which is Middle Ordovician. Approximately this same age was assigned by Hewitt (1961b, p. 32) in the adjacent Equinox quadrangle to the north.

Because the Mount Anthony Formation has so far not yielded fossils, its age lacks internal evidence. The black slate on the east slope of the Taconic Range, in the Castleton quadrangle to the north, also grades into the overlying green slate, which Zen (1961) showed to be Lower Cambrian; Zen suggested (1961, p. 313) that the black slate may conceal a thrust fault; he thus explained the observed gradational contact. Zen (1961, p. 299, 335) hinted at a correlation of the Mount Anthony Formation with his Biddie Knob Formation of Early Cam-

brian age; the two rocks indeed resemble each other. Doll and others (1961) show MacFadyen's Mount Anthony Formation as part of their St. Catherine Formation, assigned to the Early Cambrian. By comparison with the probably synchronous rocks of eastern Vermont, the St. Catherine is roughly correlated by Doll and others with the Pinney Hollow Formation, which is the Rowe Schist of Prindle and Knopf (1932). Prindle and Knopf also called the Mount Anthony the Rowe Schist, of Early Cambrian age; the wheel has indeed turned a full circle.

Doll and others also show the St. Catherine as extending from West Mountain, north of Mount Anthony, through the Equinox quadrangle north to Dorset Mountain in the Pawlet quadrangle. West Mountain was mapped by MacFadyen as a separate area of the Mount Anthony; the use of MacFadyen's name was expanded and extended into the Equinox quadrangle by Hewitt (1961b), apparently as a strict synonym for the Berkshire Schist of Dale (1912). The Dorset Mountain mass was called the Berkshire Schist by Dale (1912) and the Greylock Schist by Thompson (1959, p. 83). The latter designation agrees with Prindle and Knopf's correlation and apparently also with Dale's original intention.

MOUNT HAMILTON FORMATION

(Doll and others, 1961)

Calciferous (Unit F; in part)+Hudson Shales (Unit G)+Hudson White Beds (Unit Hw)+Hudson Thin Quartzite (Unit Hg)+Hudson Red and Green Slate (Unit Irs), Dale, 1899, table facing p. 178.
Indian River Slate+Poultney Slate (in part?), Keith, 1932, p. 403. Normanskill Graywacke, Red Slate, Quartzite, and Cherts, Larrabee, 1939, p. 48.
Normanskill Formation, Kaiser, 1945, p. 1090.
Normanskill Formation (in part), Fowler, 1950, p. 55.
Indian River Formation+Poultney Formation, Theokritoff, 1959a, p. 56.
Indian River Slate+Poultney Slate, Theokritoff, 1959b.
Units 1, 2, 3, 5, Poultney River Group, Zen, 1959, p. 2.
Indian River Slate+Poultney Formation, Berry, 1959, p. 61.
Indian River Slate+Poultney Slate, Berry, 1961, p. 226.
Units, 1, 2, 3, 4, 6, Mount Hamilton Group, Zen, 1961, p. 306.
Poultney Formation (+other units), Hewitt, 1961b, p. 40.
Indian River Slate+Poultney Slate, Zen, in press.

Type locality.—None given, but presumably at Mount Hamilton, town of Fair Haven, Vt. (Benson 7½-minute quadrangle, New York-Vermont).

Original description.—"White weathered black, gray, green, purple, and red hard slates, some interbedded with thin cherty appearing quartzites and ribbon limestones a few inches apart; smooth, soft red slate; beds of ankeritic quartzite a few inches to several feet thick,

locally containing layers of edgewise conglomerate; and a polymikt limestone conglomerate. Lithic features vary laterally and are in many places indistinguishable from the underlying Hatch Hill and West Castleton Formations."

Age.—Early to Middle Ordovician.

Remarks.—The Mount Hamilton Formation of Doll and others (1961) differs from Zen's Mount Hamilton Group (1961) by excluding the beds designated as Unit 5 and associated strata by Zen (1961, p. 306) and as the Hatch Hill Formation by Theokritoff (1959a, p. 55). The name Mount Hamilton Formation is synonymous with the combination of the Indian River Slate and the Poultney Slate, as used by Keith (1932, p. 403; some Hatch Hill beds may be included in Keith's Poultney Slate), Theokritoff (1959a; 1959b), Berry (1959; 1961), Shumaker (1960, p. 28), and Zen (1963). See Zen (1963, p. 93) and Doll and others (1963, p. 94) for further discussion.

MOUNT HAMILTON GROUP

(Zen, 1961, p. 306)

Ferruginous Quartzite (Unit E; in part)+Calciferous (Unit F)+Hudson Shales (Unit G)+Hudson Thin Quartzite (Unit Hg)+Hudson White Beds (Unit Hw)+Hudson Red and Green Slate (Unit Irs), Dale, 1899, table facing p.178.

Poultney Slate+Indian River Slate, Keith, 1932, p. 403.

Zion Hill Quartzite+Normanskill Graywacke, Quartzite, Red Slate, Cherts, Larrabee, 1939, p. 48.

Normanskill Formation, Kaiser, 1945, p. 1090.

Normanskill Formation (in part), Fowler, 1950, p. 55.

Zion Hill Quartzite+Schaghticoke Shale+Deepkill Shale+Normanskill Formation (in part), Billings and others, 1952, p. 36.

Hatch Hill Formation+Poultney Formation+Indian River Formation, Theokritoff, 1959a, p. 55–56.

(Unnamed) "black shales with associated rotten-weathering bluish-gray sandstone"+Poultney Slate+Indian River Slate, Theokritoff, 1959b, p. 1686.

Hatch Hill Formation+Poultney Slate+Indian River Formation, Berry, 1959, p. 61, 62.

Poultney River Group (less Unit 6), Zen, 1959, p. 2.

Poultney River Group (less Unit 6), Zen, 1960a, p. 131.

Unnamed unit (=Hatch Hill Formation)+Poultney Slate+Indian River Slate, Berry, 1961, p. 224, 226.

St. Catherine Formation (in part)+Undifferentiated Hatch Hill-West Castleton Formations (in part)+Mount Hamilton Formation, Doll and others, 1961.

Poultney River Group (in part?), Hewitt, 1961b, p. 41.

Hatch Hill Formation+Poultney Slate+Indian River Slate, Zen, in press.

Type locality.—Mount Hamilton, town of Fair Haven, Vt. (Benson 7½-minute quadrangle, Vermont-New York).

Original description.—(1) A green or grayish-green, very fine grained argillite, commonly interbedded with a slightly calcareous, fine-grained quartzite at intervals of about 1 foot; (2) a dark gray

to sooty-black, "cherty"-looking, siliceous argillite; (3) a deep-red to purple, hard argillite that weathers white to green; (4) a purplish-red to vermillion, soft slate with interbedded thin green quartzite; (5) a massive, dark-gray calcareous quartzite, which on a fresh surface glistens with rounded quartz grains but upon weathering becomes red brown, loose and spongy, ribbed with thin white quartz veins, and which is interbedded with sooty black slate; and (6) a limestone conglomerate in a dove-gray and gray-weathering limestone matrix. (Zen, 1961, p. 306–307).

Age.—Late Cambrian to Middle Ordovician.

Remarks.—Despite the variety of names employed, modern workers in the Taconic region generally agree on the stratigraphy, lithology, and age of the units in Zen's Mount Hamilton Group. This group has now been divided into individual formations, as indicated in the synonymy, and these formations are separately discussed. The Mount Hamilton Group and the Pawlet Formation were collectively called the Poultney River Group by Zen (1959, p. 2).

The top of the Mount Hamilton Group is the base of the Pawlet Formation; the base of the Group, however, cannot always be located in the field, especially where black slates of the Group rest on the Lower Cambrian black slates of the West Castleton Formation. This basal contact may represent a widespread unconformity (Fisher, 1956, p. 331; Platt, 1960, p. 37; Zen, 1963).

Rocks similar to those of the Mount Hamilton Group, and of like age, are extensive throughout the Taconic region. Problems of equivalence and correlation of individual units are considered under the separate formation names; broad equivalences are shown below:

Central Taconic region

Eagle Bridge Quartzite+Deepkill Slate+Normanskill Shale (in part), Prindle and Knopf, 1932, p. 279.

Deepkill pyritiferous black slate+Eagle Bridge Quartzite+laminated gray argillite and cherty slate+Middle Ordovician Normanskill thin-bedded quartzite, red slate, and bedded chert, Potter, 1959.

Poultney Formation+Other units, Hewitt, 1961b, p. 40.

Southern Taconic region

Deepkill Shale and Limestone+calcareous sandstone+limestone conglomerate+chert beds+Normanskill Shale+Mount Merino Chert, Craddock, 1957, p. 682, 691.

Elizaville Shales (in part)+Trenton black slate (in part?), Weaver, 1957, p. 739, 743.

Germantown Formation+Stuyvesant Falls Formation+Normanskill Group (in part), Fisher, 1961, p. D9.

Burden Iron Ore+Zion Hill Quartzite (+younger units not considered in this reference), Fisher, 1956, p. 330, 345.

Schodack Formation (in part)+Deepkill Shale+Normanskill Formation (in part)+Nassau Beds, Goldring, 1943, p. 68, 90, 99.

Schodack Shales and Limestones (in part)+Nassau Beds (in part)+Schaghticoke Shale+Deepkill Shale+Mount Merino Chert and Shale of the Normanskill Formation, Ruedemann, 1942a, p. 62, 78, 88.

Schodack Shales and Limestones+Schaghticoke Shale+Deepkill Shale+Normanskill Shale (in part), Ruedemann, *in* Cushing and Ruedemann, 1914, p. 66.

Nassau Beds (in part)+Schodack Shale and Limestone (in part)+Schaghticoke Shale+Deepkill Shale+Normanskill Shale (in part), Ruedemann, 1930, p. 80, 85, 86, 96.

Beekmantown Shale+Hudson Shale+Hudson Schist (in part), Dale, 1904, p. 30, 33.

Schaghticoke Shale+Deepkill Shale+Members 1, 2 and 3 of Normanskill Shale, Berry, 1962, p. 698, 699, 709.

MOUNT MERINO MEMBER (OF THE NORMANSKILL SHALE)

(Twenhofel and others, 1954, Column 14)

Mount Moreno (Shales of Normanskill), Ruedemann, 1901a, p. 547.

Hudson Shale (in part), Dale, 1904, p. 33.

Hudson Formation (in part), Dale, 1904, p. 35.

White weathering cherty beds (of the Normanskill Formation), Ruedemann, *in* Cushing and Ruedemann, 1914, p. 85.

Normanskill Shale (in part), Ruedemann, 1930, p. 96.

Mount Merino Chert and Shale (of the Normanskill Formation), Ruedemann, 1942a, p. 90.

Mount Merino Chert, Goldring, 1943, p. 102.

Red Shale Unit+Mount Merino Unit, Normanskill Terrane, Craddock, 1957, p. 687, 688.

Indian River Slate+Mount Merino Black Shale and Chert (of the Normanskill Group), Fisher, 1961, p. D9.

Red and Green Chert and Shale Member+Gray Mudstone and Black Shale Member+White-weathering Black and Green Chert and Siliceous Argillite Member (of the Normanskill Shale), Berry, 1962, p. 711, 712.

Mount Merino Member (of the Normanskill Formation), Knopf, 1962, p. 36.

Type locality.—Mount Merino, town of Greenport, N.Y. (Catskill 15-minute quadrangle, New York).

Original description.—None specifically given (see "Remarks" below).

Age.—Middle Ordovician.

Remarks.—Craddock (1957) found that in the Kinderhook quadrangle, New York, the graptoliferous Normanskill beds underlying the distinctive Austin Glen Graywacke is divisible into two units, a basal red shale and an upper variegated to black chert unit interbedded with shale. Both units appear to be part of Ruedemann's Mount Merino chert and black shale beds, as amplified and described by Ruedemann (1942a, p. 92–101). This same lithic succession is found by Elam (1960) in the area just south of Troy, N.Y., which is part of Ruedemann's 1930 report area; comparable successions are

found in Dutchess County farther south (A. S. Warthin, Jr., oral communication, 1959).

The sequence of a lower red shale and an upper black shale and chert is present in the Cossayuna quadrangle (Platt, 1960, p. 41). Berry (1962) further refined the subdivision into three units for which he gave no formal names but gave detailed lithologic descriptions; equivalences of the different units of these workers are discussed in the section on "Indian River Slate." In the northern Taconic region, on the other hand, the cherty beds within the Mount Merino equivalent are largely absent, and the black shale that occurs below the graywacke of the overlying Pawlet Formation seems to belong stratigraphically to the Pawlet. This absence of cherty beds may be due to nondeposition, to lateral facies variation, or to erosion in pre-Pawlet time.

The following stratigraphic names have been used in the northern Taconic region for rocks of the Mount Merino equivalent. The comparison is primarily lithic, although available faunal evidence is consistent with treating the suggestions here presented as correlations. Compare Berry (1959; 1961; 1962) with Berry (1960) and Ruedemann (1942a; 1947).

Northern Taconic region

Normanskill Formation (in part, particularly the red slates), Larrabee, 1939, p. 48.

Normanskill Formation (in part), Fowler, 1950, p. 55.

Hudson Red and Green Slate (Unit Irs)+(possibly) parts of Hudson Thin Quartzite (Unit Hg)+(possibly) parts of Hudson White Beds (Unit Hw), Dale, 1899, table facing p. 178.

Mount Hamilton Group, Unit 4, Zen, 1961, p. 306.

Mount Hamilton Formation (in part), Doll and others, 1961.

Indian River Formation (+parts of the Poultney Formation?), Theokritoff, 1959a, p. 56.

Indian River Slate (+parts of the Poultney Slate?), Theokritoff, 1959b.

Indian River Formation (+parts of the Poultney Formation?), Berry, 1959, p. 61.

Indian River Slate (+parts of the Poultney Slate?), Berry, 1961, p. 226.

Indian River Slate (+parts of the Poultney Slate?), Zen, in press.

Central Taconic region

Normanskill red slate and bedded chert, Potter, 1959.

Normanskill Shale (in part), Prindle and Knopf, 1932, p. 279.

MUDD POND QUARTZITE MEMBER (OF THE BULL FORMATION)

(Zen, 1961, p. 303)

Black Patch Grit (Unit C; in part)+Cambrian Roofing Slate (Unit B; in part), Dale, 1899, p. 180, 181.

Eddy Hill Grit+Mettawee Slate (in part), Ruedemann, *in* Cushing and Ruedemann, 1914, p. 69.

Bull Slate (in part), Swinnerton, 1922, p. 69.

Bull Slate (in part), Keith, 1932, p. 400.
Eddy Hill Grit+Mettawee Slate (in part), Larrabee, 1939, p. 48, 51.
Eddy Hill Grit+Mettawee Slate (in part), Kaiser, 1945, p. 1085, 1086.
Eddy Hill Grit (in part)+Mettawee Slate (in part)+Nassau Formation (in part), Fowler, 1950, p. 38, 49.
Eddy Hill Grit+Mettawee Slate (in part)+Nassau Formation (in part), Billings and others, 1952, p. 37.
Mettawee Slate Member (in part) of the Bull Formation, Theokritoff, 1959b.
Slate and phyllite strata (in part) of the St. Catherine Formation, Doll and others, 1961.

Type locality.—South shore of Mudd Pond, town of Hubbardton, Vt. (Bomoseen 7½-minute quadrangle, Vermont).

Original description.—"Hard, vitreous, buff to gray, uniform and medium grained, quartz is [the rock's] predominant constituent. Locally the rock has a slightly dolomitic cement and dolostone lenses. * * * The quartzite weathers white to buff and smooth, with a waxy luster. [It] locally grades into a gray arkosic grit, with black argillaceous cement [=Eddy Hill lithology]."

Age.—Called Early Cambrian by Zen (1961); the age determination of this rock depends entirely on the Early Cambrian age determination for the conformably overlying North Brittain Conglomerate. The age should be Cambrian(?).

Remarks.—The Mudd Pond Quartzite occurs near the top of the Bull Formation of Zen (1961), below the horizon of the North Brittain Conglomerate Member (Zen, 1961, p. 303). Locally (Zen, 1959, p. 11, 12), two beds of quartzite actually exist in the Mudd Pond; the beds are separated by as much as 50 feet of slate typical of the Mettawee.

The Black Patch Grit of Dale (1899), named the Eddy Hill Grit by Ruedemann (*in* Cushing and Ruedemann, 1914), is a lithic variant of the Mudd Pond at the type locality of the Eddy Hill (Zen, 1961, p. 303); indeed, all lithic types intermediate between the Eddy Hill and the type Mudd Pond may be found. Dale's Black Patch Grit, however, includes dark-colored quartzites that Zen included in the basal part of the Zion Hill Quartzite and Greywacke Member (Zen, 1961, p. 298, table 1). The name Eddy Hill has been used in different senses in the literature and consequently is unsatisfactory as a stratigraphic name (Lochman, 1956, p. 1339; Zen, 1961, p. 305).

The bulk of Zen's Mudd Pond has not been separately mapped by previous workers; rather it has been included as part of the Mettawee Slate or its nomenclatorial equivalents, as indicated in the synonymy.

In the southern Taconic region, the Diamond Rock Quartzite in Lansingburgh, near Troy, N.Y. (Ruedemann, *in* Cushing and Ruedemann, 1914, p. 70; Fisher, 1956, p. 331; 1961, p. D8) contains Lower Cambrian fossils. This rock, which is Dale's (1904, p. 29) Unit G of the Rensselaer County succession, may well be correlative with the

Mudd Pond Quartzite. In the Nassau and East Chatham quadrangles east of Troy, in the type section of Dale's 1904 succession, the Unit G is lithically much like the Mudd Pond and is at a corresponding stratigraphic position (T. W. Talmadge, and J. M. Bird, written communications, 1961).

NASSAU BEDS

(Ruedemann, *in* Cushing and Ruedemann, 1914, p. 70)

Units A–E, Dale, 1904, p. 29.
Greenwich Formation (in part), Dale, 1904, p. 50.
Nassau Formation, Howell and others, 1944, column 69.
Nassau Shale and Grit, Fisher, 1956, p. 337.
[Nassau] green slate terrane, Craddock, 1957, p. 691.
Elizaville Shales (in part?), Weaver, 1957, p. 739.
Nassau Formation+Austerlitz Phyllite(?)+Mettawee Slate+Elizaville Shale (in part?)+Curtiss [sic] Mountain Quartzite (in part?), Fisher, 1961, p. D5, D6, D8.
Nassau Formation (in part) Bird 1962a p. 135.

Type locality.—Town of Nassau, N.Y. (Nassau 7½-minute quadrangle, New York).

Original description.—"Greenish, or reddish and greenish, shale with small quartzite or grit beds; massive green quartzite, in places very coarse" (Dale, 1904, p. 29).

Age.—Originally called Early Cambrian; the rock should, however, be given a Cambrian(?) age because the lowest fossiliferous Early Cambrian rocks occur conformably above the Nassau Beds.

Remarks.—The lower five units of Dale's (1904) Lower Cambrian sequence of Rensselaer and Columbia Counties, N.Y., Units A–E, were collectively called the Nassau Beds by Ruedemann (*in* Cushing and Ruedemann, 1914), and considered to be "Lower Cambric" (1914, p. 68) because they contain *Oldhamia.* Ruedemann (1942a, p. 42) reassigned the rocks to the Precambrian, but the lithostratigraphic usage of the name Nassau Beds remains unchanged in his various publications (1929, p. 414; 1930, p. 83; 1942a, p. 38).

Goldring (1943, p. 56) ostensibly followed Ruedemann's usage of the name Nassau, but in the description of typical localities she included outcrops atypical of the Nassau (p. 57, 61), the rocks concerned being interbedded green, gray, and black slate, calcareous quartzite, and edgewise limestone conglomerate. One of these localities, at Judson Point, was recently included by Fisher (1961, p. D8) under his discussion of the Schodack Formation.

Ruedemann (*in* Cushing and Ruedemann, 1914) suggested that the Nassau Beds are Early Cambrian in age, but older than the Mettawee Slate and Bomoseen Greywacke of the northern Taconic region. Fisher (1956, p. 337) concurred on the Early Cambrian age for the

Nassau Beds but advocated that they are synchronous with the Mettawee and the Bomoseen. Fisher (1961, p. D8) reaffirmed this revised correlation and age assignment, stating that the Nassau "is clearly a quartz-rich facies of the Mettawee." Fisher (1961) also included the Ashley Hill Limestone of Dale (1892, p. 312) in the upper part of his Nassau. The Ashley Hill is Unit I of Dale (1904, p. 29); Ruedemann (1930, p. 79) included the Ashley Hill in his Schodack Shale and Limestone. Craddock (1957, p. 691, 694) followed Ruedemann's nomenclature, and Lochman (1956, p. 1340) referred to the Ashley Hill as part of her Schodack Lithofacies. Fisher, therefore, included in the Nassau, not only Ruedemann's Mettawee and Bomoseen, but part of his Schodack as well. In this usage, Fisher anticipated the redefinition of Bird (1962a).

Despite the conflicting terminology, recent fieldwork in the Columbia and Rensselaer Counties area shows that Dale's Units A–H do constitute an integral, though heterogeneous, succession that is most readily mapped as a single formation (Elam, 1960; Talmadge, written communication, 1961; Bird, 1962a, b.). This enlarged unit is the Nassau Formation of Bird.

The Nassau Beds of Ruedemann (1942a) in the Catskill quadrangle are at least partly continuous with Dale's Units A–E, or Craddock's Nassau rocks, of the Kinderhook quadrangle through the Copake quadrangle. Weaver (1957, p. 739), however, mapped these intervening areas as his Elizaville Shales, which he assigned to the Upper Cambrian and Lower Ordovician, he thus precluded a continuation of the rocks from one area to the other. Fisher (1961, p. D6) suggested that the Elizaville be correlated with the Nassau. The Elizaville may in addition contain rocks younger than Early Cambrian because it contains rock types reminiscent of the Poultney Slate.

Fowler (1950, p. 38) referred extensive areas of argillites in the southern part of the Castleton quadrangle in Vermont to the Nassau Formation and, following Ruedemann (1942a), assigned to it a Precambrian age. Fowler rejected a correlation of these beds with his Mettawee Slate and associated strata immediately north of the Castleton River, because his Mettawee is Early Cambrian. Fowler's Nassau is now returned to the Early Cambrian by Zen (in press) and reassigned to the Bull Formation which contains the Mettawee; the changes in the Nassau type area confirm these changes in the north.

NASSAU FORMATION

(Bird, 1962a, p. 135)

Units A–I+Rensselaer Grit, Dale, 1904, p. 29, 39.

Greenwich Formation (less the beds called the West Castleton Formation by Bird, 1962b)+Rensselaer Grit, Dale, 1904, p. 39, 50.

Nassau Beds+Schodack Shales and Limestones (in part)+Eddy Hill Grit+Mettawee Slate+Bomoseen Grit+Diamond Rock Quartzite+Troy Shales+Zion Hill Quartzite(?), Ruedemann, *in* Cushing and Ruedemann, 1914, p. 68–70.

Nassau Beds+Bomoseen Grit+Diamond Rock Quartzite+Schodack Shale and Limestone+Troy Shale+Rensselaer Grit, Ruedemann, 1930, p. 79.

Nassau Beds+Schodack Formation (expanded; in part), Ruedemann, 1942a, p. 63, 65.

Nassau Beds+Schodack Formation (expanded; in part), Goldring, 1943, p. 56, 64.

Nassau Formation+Bomoseen Formation, Howell and others, 1944, column 69.

Nassau Formation+Diamond Rock Quartzite+Troy Shale+Schodack Shale and Limestone+Rensselaer Grit or Graywacke, Fisher, 1956, p. 337, 339.

[Nassau] green slate terrane+Rensselaer Graywacke, Craddock, 1957, p. 691.

Elizaville Shales (in part?), Weaver, 1957, p. 739.

Nassau Formation+Mettawee Slate+Bomoseen Subgraywacke+Elizaville Shale+Curtiss [sic] Mountain Quartzite+Austerlitz Phyllite(?)+Rensselaer Graywacke, Fisher, 1961, p. D4–D8.

Nassau Beds+Diamond Rock Quartzite+Schodack Shale and Limestone, Knopf, 1962, p. 37.

Type locality.—Town of Nassau, N.Y. (Nassau 7½-minute quadrangle, New York).

Original description.—None given; see Dale (1904, p. 14–17).

Age.—Cambrian(?) and Early Cambrian.

Remarks.—The name Nassau Formation was first used by Howell and others (1944) as a synonym of Ruedemann's (*in* Cushing and Ruedemann, 1914, p. 70) Nassau Beds. The same name was used by Fowler (1950, p. 38) in the northern Taconic region in the same sense, although Fowler included the Bird Mountain Grit in his Nassau. Because Fowler assigned the Nassau to the Precambrian(?) and correlated the Bird Mountain Grit with the Rensselaer Graywacke, he implied a Precambrian(?) age for the Rensselaer, contrary to Ruedemann's separate mapping and age designation for these two units at their type areas.

Fisher (1961, p. D8) included the Ashley Hill Limestone of Dale (1892) in his Nassau Formation and correlated the formation with his Mettawee Slate; he thus expanded the Nassau to include Dale's Unit I (1904). No formal definition, however, was given.

Bird's expansion of the Nassau Formation is the most comprehensive and explicit. It includes nearly the entire Lower Cambrian succession of Dale (1904) as well as the Rensselaer Graywacke. With the exception of the black slate and limestone beds which Bird called the West Castleton Formation, therefore, the expanded Nassau is equal to the entire Lower Cambrian sequence in the area of Dale's 1904 report.

By and large, the identification of Ruedemann's (*in* Cushing and Ruedemann, 1914) Lower Cambrian stratigraphic units with Bird's

Nassau Formation is clear. However, only part of Ruedemann's Zion Hill belongs here: lithic types typical of the Zion Hill, now called the Curtis Mountain Quartzite (Fisher, 1961, p. D6) should be so included, but lithic types called the Zion Hill by Ruedemann elsewhere (for instance, 1942a, p. 65) are different, probably much younger, and belong to Fisher's Germantown Formation (1961, p. D9).

Bird equated his Nassau Formation with the Bull Formation of Zen (1961), but considered (written communication, 1961) that it may even include part or all of Zen's Biddie Knob Formation. Bird's Nassau, then, may be a synonym of the St. Catherine Formation of Doll and others (1961). The top of both the Bull (or St. Catherine) and the Nassau are definitely Early Cambrian, as fixed by fossils in the North Brittian Member and in the Ashley Hill Conglomerate, respectively.

NORMANSKILL SHALE

(Clarke, 1903, p. 17)

Synonymy.—Spelling variants.

Normans kill Shales, Ruedemann, 1901a, p. 567.
Normans kill Beds, Ruedemann, 1901a, p. 567.
Normanskill Formation, Ruedemann, 1942a, p. 88.
Normanskill Formation, Goldring, 1943, p. 99.
Normanskill Shales, Craddock, 1957, p. 682.
Normanskill Terrane, Craddock, 1957, p. 687.
Normanskill Group, Fisher, 1961, p. D9.
Normanskill Formation, Knopf, 1962, p. 36.

Type locality.—Normans Kill, Kenwood, City of Albany, N.Y. (Albany 7½-minute quadrangle, New York) and town of Bethlehem, N.Y. (Delmar 7½-minute quadrangle, New York.).

Age.—Originally assigned to the Early to Middle Ordovician (Ruedemann, 1901a). Recent work shows the unit to be upper Middle Ordovician (Berry, 1962, p. 714).

Remarks.—Although the Normanskill Shale was first named by Ruedemann (1901a), the spelling and lithic designation of Clarke was accepted by Twenhofel and others (1954). No attempt has been made to search the literature for all the variant spellings and rock designations of this unit, nor for all the names of formations that were, or are, thought to be equivalent to or subdivisions of this unit; to do so would require a thorough review of the problem of the Normanskill as a whole, in all its stratigraphic, structural, and paleontologic ramifications, an undertaking that is beyond the scope of this study. In the synonymy, therefore, only representative spelling variants and lithic-designation variants for the area near the type locality are given.

The Normanskill Formation of Ruedemann (1942a) included as its two members the Mount Merino and the Austin Glen; problems of

intra-Taconic correlation have been briefly dealt with under these member names. The following northern Taconic stratigraphic names or units are at least in part equivalent to the Normanskill Formation of Ruedemann (1942a): Hudson Thin Quartzite (in part; Dale, 1899); Hudson Red and Green Slate (Dale, 1899); Hudson White Beds (in part; Dale, 1899); Hudson Grits (Dale, 1899); Poultney Slate (in part; Keith, 1932); Indian River Slate (Keith, 1932); Normanskill Grit, Slate, Cherts, and Graywacke (in part; Larrabee, 1939); Normanskill Formation (in part; Kaiser, 1945; Fowler, 1950); Pawlet Formation (Zen, 1961); Mount Hamilton Group (in part; Zen, 1961); Mount Hamilton Formation (in part; Doll and others, 1961). See also Berry (1962).

In the central and southern Taconic area, the name Normanskill has been preserved, with various lithic designations. See, for instance, Hartnagel (1912); Ruedemann (*in* Cushing and Ruedemann, 1914); Ruedemann (1929; 1930; 1942a; 1947); Prindle and Knopf (1932); Ruedemann and Wilson (1936); Goldring (1943); Potter (1959); Fisher (1961); and unpublished theses of Talmadge (1956), Elam (1960), and Platt (1960). Berry (1962) made an especially elaborate restudy of the paleontology and stratigraphy of the Normanskill; he also further subdivided Ruedemann's Mount Merino Member into three lithic units, discussed elsewhere in this paper in the section on the "Mount Merino Member."

NORTH BRITTAIN LIMESTONE CONGLOMERATE MEMBER (OF THE BULL FORMATION)

(Zen, 1961, p. 303)

Limestone Breccia, Swinnerton, 1922, p. 72.
Castleton Limestone Conglomerate, Zen, 1959, p. 2.
Castleton Conglomerate Member (of the Bull Formation), Hewitt, 1961b, p. 33.

Type locality.—Valley of the North Brittain Brook, town of Castleton, Vt. (Bomoseen 7½-minute quadrangle, Vermont).

Original description.—"A slate-matrix, limestone-pebble conglomerate [whose pebbles, poorly sorted, are] in a green to gray slaty, noncalcareous matrix; the ratio of matrix to pebbles varies. The pebbles * * * are dominantly either dark-gray limestone weathering dove gray, or white to creamy limestone weathering buff. [Locally] salmon-colored, hematitic limestone pebbles are abundant in a purple slate matrix * * *. Rarely * * * the matrix is a dark-gray arkose like the Eddy Hill Grit."

Age.—Early Cambrian (carries the *Elliptocephala asaphoides* fauna).

Remarks.—Dale (1899, p. 181), Larrabee (1939, p. 49), Fowler (1950, p. 47), and probably Keith (1932, p. 402), all recognized this

rock unit near the top of the Mettawee Slate (=Cambrian Roofing Slate of Dale or the Bull Slate of Keith) in the northern Taconic region, and Dale (1899) at least was aware of its fossil contents. The rock, despite its lithic distinctness, age significance, and wide distribution, was not separately mapped until Zen (1959) mapped it under the name of the Castleton Limestone Conglomerate, a name later abandoned because of possible confusion with the West Castleton Formation. The unit is now recognized by all workers in the northern Taconic region, and Theokritoff (1959a, p. 54) made extensive fossil collections from it. Zen (1961, p. 304) pointed out that because the conglomerate is probably intraformational (see also Zen, 1959, p. 8), the fossil contents fix the age of the enclosing matrix as well.

In the southern Taconic region, the rock appears to be the same as Dale's (1892) Ashley Hill Limestone, now called the Ashley Hill Limestone Conglomerate and included by Bird in his Nassau Formation (Fisher, 1961, p. D8; Bird, 1962a, p. 136). Fisher (1961, p. D8) compared the Ashley Hill with the Stuyvesant Conglomerate and noted the identity of their fossils.

The type locality assigned by Ruedemann (1930, p. 80) to the Schodack Shales and Limestones was described in detail by Goldring (1943, p. 68). Here the rock is lithically the same as the North Brittain, as first pointed out by Theokritoff (1957). This view is concurred with by Fisher (1961, p. D8). The name Schodack has been used for the overlying Cambrian black shale of Dale (1899, p. 182) in the northern Taconic region, however, by Ruedemann (*in* Cushing and Ruedemann, 1914), Larrabee (1939, p. 51), Kaiser (1945, p. 1087), Fowler (1950, p. 50), and Billings and others (1952, p. 37); this black shale is the overlying West Castleton Formation of Zen (1961, p. 298).

PAWLET FORMATION

(Zen, 1961, p. 307)

Hudson Grits (Unit Ig), Dale, 1899, p. 187.
Unnamed black slate, Keith, 1932, p. 403.
Normanskill Grit, Larrabee, 1939, p. 51.
Normanskill Formation (in part), Fowler, 1950, p. 55.
Unit 6, Poultney River Group, Zen, 1959, p. 2.
Austin Glen Graywacke Member (of the Normanskill Shale), Berry, 1962, p. 712.

Type locality.—Town of Pawlet, Vt. (Pawlet 15-minute quadrangle, Vermont.

Original description.—"Roughly equal amounts of slate and graywacke; the base of the formation is everywhere a slate. The slate ranges from silky gray and silty to jet black, graphitic and pyritiferous; * * * in places the jet black and fine-grained slate is graptolif-

erous. At intervals of a few inches to tens of feet are beds of massive graywacke which is dark gray on a fresh surface but weathers rusty gray brown. The graywacke ranges from a few inches to 6 feet thick. It contains subangular grains of quartz, with subsidiary feldspar and slate fragments, in a gray argillaceous matrix which is locally slightly calcareous. The graywacke commonly shows graded bedding."

Age.—Middle Ordovician (zone 12 of the Marathon, Tex. graptolite succession, Berry, 1960); see Berry (1962, p. 713).

Remarks.—The name Pawlet (Graywacke) was first used by Shumaker (1960, p. 36), but its first publication was by Zen with Shumaker's permission (written communication, 1960). The Pawlet Formation and its equivalent and correlative units form a distinctive rock unit found through the Taconic region, from Poultney, Vt. to Poughkeepsie, N.Y. (Gordon, 1911; A. S. Warthin, Jr., oral communication, 1959; Berry, 1962). In the southern Taconic region the Pawlet equivalent is the Austin Glen Member of the Normanskill Formation (Ruedemann, 1942a, p. 89; Goldring, 1943, p. 104), to which other names have also been applied (see "Austin Glen Member"). The name, Austin Glen, was applied by Berry (1962) to areas in the northern Taconic region, including areas mapped by Shumaker (1960) and Zen (1961; in press) as the Pawlet. The equivalence and correlation of the Pawlet Formation and the Austin Glen Member is, however, beyond reasonable doubt. Both units carry the same graptolite fauna characterizing the *Climacograptus bicornis* zone (zone 12) of Berry (1960; see also 1959; 1962, table 4; Ruedemann, 1942a) and the rocks are lithically identical. In both areas, the rocks rest on the lower Normanskill Mount Merino Member or its partial equivalent Indian River Slate. In the northern Taconic region, however, the Pawlet Formation is locally unconformably above older rocks (Zen, 1961, p. 308; in press; Berry, 1962, p. 713).

Because the Pawlet Formation and its equivalent units are the youngest formations of the Taconic sequence, their relation to the surrounding, undoubtedly autochthonous Middle Ordovician black slate (Walloomsac, Snake Hill, Ira, Hortonville, Berkshire, Canajoharie, and so on) is of utmost importance to the solution of the structural problem of the Taconic rocks. Potter (1959) found that in the vicinity of Hoosick Falls, N.Y., the Pawlet-equivalent Normanskill Graywacke grades laterally into the black slates of the Walloomsac. A similar lithic interdigitation was reported by Ruedemann (in Cushing and Ruedemann, 1914, p. 95) at the type locality of the Snake Hill Shale, and was also described in the Troy, N.Y. area by Elam (1960, p. 57). Zen (1960b) suggested the contemporaneity of these rocks on the basis of regional tectonic and sedimentary relations; he

later (in press) suggested that the Pawlet Formation was deposited during the emplacement of the Taconic klippe and that it is therefore transitional between the autochthone and the allochthone in its tectonic-sedimentary framework, comparable with the "neoautochthonous" rocks of the northern Apennine region of Italy (Maxwell, 1959, p. 2710).

POULTNEY SLATE

(Keith, 1932, p. 403)

Calciferous (Unit F)+Hudson Shales (Unit G)+Hudson White Beds (Unit Hw)+Hudson Thin Quartzites (Unit Hg), Dale, 1899, p. 185, 186.
Normanskill Slate, Quartzite, and Cherts (in part), Larrabee, 1939, p. 51.
Normanskill Formation (in part), Kaiser, 1945, p. 1090.
Normanskill Formation (in part), Fowler, 1950, p. 55.
Units 1–3, Poultney River Group, Zen, 1959, p. 2.
Poultney Formation, Theokritoff, 1959a, p. 56.
Units 1, 3, 6, Mount Hamilton Group, Zen, 1961, p. 306–307.
Mount Hamilton Formation (in part), Doll and others, 1961.
Poultney Formation, Hewitt, 1961b, p. 40.
Poultney Slates, Hewitt, 1961b, p. 41.

Type locality.—Town of Poultney, Vt. (Castleton 15-minute quadrangle, Vermont).

Original description.—"Gray slate which becomes lighter or even white on exposure. The most prominent feature of the formation is white or light gray chert which appears in very thin seams or in massive beds a foot or so thick."

Age.—Called Early Ordovician by Keith, the age of the rock is now known to be Early to Middle Ordovician (Berry, 1961, p. 226).

Remarks.—The graptolite faunas of the Poultney Slate have recently been studied by Berry (1961), who referred the lower part of the unit to the Lower Ordovician, but the upper part to the Middle Ordovician. Keith's original definition of the Poultney Slate is scanty and does not suffice to define the rock in the field. Recent mapping at or near the type locality, by Theokritoff (written communications; 1959a, b), Zen (1959; 1961; in press), and Shumaker (1960, 1962), and the faunal restudy of Berry (1959; 1961), show the equivalence of the Poultney Slate with Dale's rock units (1899), as indicated, except that Dale's Calciferous may include some rocks now assigned to the underlying Hatch Hill Formation. The Poultney is fairly readily distinguished from the overlying Indian River Slate (Dale's Hudson Red and Green Slate) on lithic bases. The upper Poultney is faunally like the Indian River (W. B. N. Berry, written communication 1961), however, and belongs to the *Nemagraptus gracilis* or *Climacograptus bicornis* zone. The Poultney and Indian River Slates are collectively called the Mount Hamilton Formation by Doll and others (1961).

Theokritoff (1959b) pointed out that the lowest beds of the Poultney Slate, his A-member (written communication, 1961), is lithically identical with the type Schaghticoke Slate (Ruedemann, 1903, p. 934; O'Brien, 1960). This comparison accords with the results of Berry's faunal work (1961, p. 225). Theokritoff's Poultney A-member was in part incorrectly mapped by Zen (1961, pl. 2, fig. 3) as the Lower Cambrian West Castleton Formation, but it was reassigned to the Poultney Slate later (Zen, in press). This A-member is similar to the upper beds of Fisher's Germantown Formation (1961, p. D9 and D21, stop 14) of the southern Taconic region. (See also Berry, 1962, p. 708.)

The bulk of the Poultney Slate, Theokritoff's B- and C-members (written communication, 1961), are Zen's (1961, p. 306–307) units 1, 3, and 6 of the Mount Hamilton Group. Zen's units collectively correspond to Dale's (1899) units G, Hw, and Hg, and apparently to Keith's entire Poultney Slate. The rocks are recognized in the Cossayuna quadrangle, New York (Platt, 1960). In the southern Taconic region, equivalent and probably correlative rocks are Fisher's (1961, p. D9) Stuyvesant Falls Formation. A particular limestone conglomerate near Snyders Lake in Troy South quadrangle, New York, mapped by Dale (1904, p. 15) and Ruedemann (1930, p. 77) as Lower Cambrian, is similar to unit 6 of Zen's Mount Hamilton Group (1961, p. 307) and also to the Claverack Conglomerate of Chadwick (1946). D. W. Fisher (written communication, 1961) placed the Claverack at the top of his Germantown Formation, which is not inconsistent with the other data cited above. Elam (1960, p. 44) assigned the Snyders Lake outcrop to a unit equivalent to the Poultney Slate.

The Poultney Slate is probably equivalent to the bulk of Craddock's (1957, p. 682, 691) "Deepkill" units, as well as possibly part of Weaver's (1957, p. 739) Elizaville Shales. The type Deepkill beds of Ruedemann (1902, p. 547) at Grant Hollow, N.Y. (Berry, 1962; Lowman, 1962b, p. 221) is a correlative of a part of the Poultney (Berry, 1961, p. 226; 1962, p. 707) on faunal evidence. The same correlation may be extended to other fossiliferous Deepkill beds of the southern Taconic region (Ruedemann, *in* Cushing and Ruedemann, 1914, p. 75; Ruedemann, 1930, p. 86; 1942a, p. 78; Goldring, 1943, p. 90; Berry, 1962, p. 708). An isolated, and so far unfossiliferous, outcrop at St. Andrew-on-Hudson near Hyde Park, N.Y., surrounded on all sides by the Austin Glen Greywacke (A. S. Warthin, Jr., oral communication, 1959) may prove to be an equivalent unit. In addition, rocks equivalent to the Poultney Slate may also be found partly in the rocks mapped as the Schodack Shales and Limestones or as the ex-

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panded Schodack Formation (Ruedemann, *in* Cushing and Ruedemann, 1914, p. 73; Ruedemann, 1930, p. 85; 1942a, p. 62; Goldring, 1943, p. 64), and partly in rocks mapped as the Normanskill (Ruedemann, *in* Cushing and Ruedemann, 1914, p. 84; 1930, p. 96; 1942a, p. 79; Goldring, 1943, p. 99). Finally, correlative beds were referred to the Deepkill Shale and possibly other units by Prindle and Knopf (1932, p. 279) and to the Beekmantown Shale and (in part) the Hudson Shale by Dale (1904, p. 30, 33).

RENSSELAER GRAYWACKE

(Prindle and Knopf, 1932, p. 280)

Rensselaer Grit, Dale, 1892, p. 306.
Rensselaer Grit, Dale, 1904, p. 39.
Rensselaer Grit, Ruedemann, 1930, p. 8.
Rensselaer Grit, Ruedemann, 1942b, p. 5.
Rensselaer Graywacke and Quartzites, Craddock, 1957, p. 692.
Rensselaer Graywackes of the Nassau Formation, Bird, 1962a, p. 135.

Type locality.—Rensselaer Plateau, Rensselaer County, N.Y. (Dale, 1892, p. 297).

Original description.—"The graywacke is a dark green to gray rock with a rather fine-grained quartz-chlorite matrix in which there are thickly scattered numerous rounded or angular fragments of slate, quartzite, limestone, schist, and gneissoid material * * * together with small fragments of grayish or colorless quartz rarely blue, microcline, and albite, and sometimes a few flakes of graphite. * * * Although the graywacke is the rock that gives prominence to the formation * * * there is a large amount of purple and green slate * * * interbedded with the graywacke."

Age.—Prindle and Knopf (1932, p. 284) tentatively suggested an Early Cambrian age for the Rensselaer Graywacke. The rock has not yielded fossils, but recent fieldwork suggests that it occurs stratigraphically near the base of Bird's (1962a) Nassau Formation in a conformable sequence. The top of the Nassau contains Lower Cambrian fossils. Therefore, the current consensus of fieldworkers is that the Rensselaer is Cambrian (?) in age.

Remarks.—The age, stratigraphic position, and structural relation of the Rensselaer Graywacke have been variously assigned in the geologic literature. Dale (1892, p. 330) assigned the rock to the Silurian (Oneida), following the original hint of Mather (1843, p. 368). Since 1892 the rock has been referred to the Precambrian (?) (Kaiser, 1945; Fowler, 1950), the Early Cambrian (Prindle and Knopf, 1932; Vaughan and Wilson, 1934; Balk, 1953, p. 859; Fisher, 1961; Bird, 1962a), the Ordovician (Ells, 1896; Fisher, 1956), the Cambrian (?) (Ruedemann, 1933), the Silurian (Hartnagel, 1907), and

the Devonian (Clarke, 1908e, p. 56; Barrell, 1913; Ruedemann, 1930; Goldring, 1943). Summaries of these vicissitudes are given by Vaughan and Wilson (1934, p. 460), Wilmarth (1938, p. 1797), Balk (1953, p. 815), and Fisher (1956, p. 339).

Prindle and Knopf (1932, p. 283) were the first to assign the rocks explicitly to the Lower Cambrian. Their view is confirmed by recent work (Craddock, 1957; Fisher, 1961; Bird, 1962a, b), primarily on the basis of lithic comparison. The only alleged fossil from this rock, *Oldhamia occidens*, reported by Vaughan and Wilson (1934, p. 460), was rejected by Ruedemann (1942b, p. 6) as being inorganic. J. M. Bird (oral communication, 1961) found interdigitation of Rensselaer-like graywacke beds with the Bomoseen Greywacke; both Bird (oral communications, 1961) and D. B. Potter (oral communication, 1962) also found interdigitation of slates similar to the Nassau Beds of Ruedemann (1930) with indisputable Rensselaer Graywacke. These findings are in accord with those of earlier workers (Dale, 1892, p. 306; Ruedemann, 1930, p. 125; Prindle and Knopf, 1932, p. 281; Balk, 1953). Consequently, Bird (1962a) considered the Rensselaer to be an integral part of this enlarged Nassau Formation, whose higher strata are Early Cambrian in age.

The lithic similarity of the Rensselaer to the "Bird Mountain Grit" in Vermont has been noted by Dale (1892, p. 337), Fowler, (1950, p. 46), and others. Zen (1961, p. 303) assigned the "Bird Mountain Grit" to the Lower Cambrian section near the base of the Bull Formation or to the top of the Cambrian(?) Biddie Knob Formation. Bird (1962a) correlated the Bull with his Nassau Formation. These independent studies reach similar conclusions concerning the stratigraphic position of the Rensselaer Graywacke or its lithic equivalent beds, and place the age of both at Cambrian(?).

RIGA SCHIST

(Hobbs, 1893, p. 726)

Berkshire Schist, Hobbs, 1897, p. 177.
Berkshire Schist (in part), Gregory and Robinson, 1907, p. 33.
Berkshire Schist (in part), Emerson, 1917, p. 39.
Salisbury Schist (in part), Agar, 1932, p. 38.
Salisbury Schist (in part), Rodgers and others, 1959, p. 9.

Type locality.—Mount Riga (called Bald Peak on the 1946 edition of the topographic map) town of Salisbury, Conn. (Bashbish Falls 7½-minute quadrangle, Massachusetts-Connecticut-New York).

Original description.—"Strictly speaking, the rock is a gneiss * * *; it almost invariably is porphyritic from the presence of lenticular to spherical grains of an acid plagioclase."

Age.—Originally assigned to the Ordovician; the rock is probably at least in part Middle Ordovician because its stratigraphic and structural position is directly comparable with that occupied by the Middle Ordovician Walloomsac, Snake Hill, Ira, and Hortonville formations. All these rock units are lithically equivalent except for the effects of different grades of metamorphism.

Remarks.—Hobbs (1893, p. 725) indicated that the Riga Schist is a synonym of Dale's Berkshire Schist (1891, p. 6; the term Berkshire Schist is here used in the original and restricted sense). In 1897, however, Hobbs abandoned the name Riga and used the name Berkshire Schist explicitly. Dale (1894b, p. 180) questioned the basis of Hobbs' correlation.

The type locality, Mount Riga on Hobbs' map (1893), is shown as Bald Peak on the 1946 edition of the 7½-minute topographic map (Bashbish Falls quadrangle); it is, however, underlain by rocks identical with Hobbs' Everett Schist. In Connecticut, the areas of Hobbs' Riga and Everett Schists are shown as underlain by the Salisbury Schist by Dana (1873, p. 25), Agar (1932), and Rodgers and others (1959); this area of the Salisbury was called the Berkshire Schist by Gregory and Robinson (1907), a name that was also used in the contiguous area in Massachusetts by Emerson (1917), apparently in the expanded sense to include both Dale's (1891) original Berkshire and Greylock Schists.

Hobbs (1893) did not clearly state his criteria for distinction between the Riga Schist and the Everett Schist. On the basis of both his descriptions of these rock units and of his geologic map, the writer concludes that the criteria are, in part, the color of the rock (the Everett is a dominantly green schist) and, in part, the mineralogy (garnet and (or) staurolite-bearing rocks are mapped as the Riga Schist; Hobbs, 1893, p. 728). These two criteria are not everywhere mutually compatible; moreover, they are not consistently followed by Hobbs. Because the presence of garnet and staurolite is controlled largely by the metamorphic grade, which in the Mount Washington area rises rapidly toward the southeast (Agar, 1932; Zen, unpublished data), Hobbs' criteria are not all stratigraphically significant. The true stratigraphic relations between the dominantly green (the Everett) and the gray-black (the Riga in part) schists in the Mount Washington area remain to be determined.

ROWE SCHIST (OF MOUNT GREYLOCK AND IN THE TACONIC RANGE)

(Prindle and Knopf, 1932, p. 289)

Greylock Schist (in part), Dale, 1891, p. 5.
Greylock Schist (in part), Dale, 1894b, 190.

Berkshire Schist (in part), Dale, 1923, pl. 1.
Mount Anthony Formation, MacFadyen, 1956, p. 28.
Greylock Schist (in part), Herz, 1958.
Greylock Schist (in part), Herz, 1961.
Mount Anthony Formation, Fisher, 1961, p. D2.
St. Catherine Formation (in part), Doll and others, 1961.
Mount Anthony Formation (upper part), Hewitt, 1961b, p. 32.

Type locality.—Town of Rowe, Mass. (Rowe 7½-minute quadrangle, Massachusetts-Vermont).

Original description.—"A thinly foliated, light grayish green phyllite [in the Hoosac Range]; * * * the chloritoid schist of [Mount] Greylock * * * occurs at many localities apparently interfolded with the albite schists; * * * the green and purple chloritoid slates on the Taconic Trail 1½ miles southeast of Moon Hill show small chloritoids sparsely distributed through a sericitic chloritic slaty matrix * * *. The purple and green phyllites [of the main Taconic Range] * * * are composed of thickly crowded chloritoids in a sericitic and chloritic matrix. * * * This rock forms a large part of the mass of the Taconics * * *. On the east side of the Taconics the purple and green phyllite continues along the trail to a point where the rock becomes gray-green and finally gray * * *; in the grayish part [there] begins to appear porphyroblastic albite."

Age.—Called Ordovician ("Lower Silurian") by Emerson (1898), the Rowe Schist at the type locality is now generally taken to be of Cambrian(?) age. If the green schists of the Taconic Range and of Mount Greylock are correctly assigned to the Rowe, then these green schists are also of Cambrian(?) age.

Remarks.—The type locality of the Rowe Schist, as described by Emerson (1898), is outside of the Taconic region and beyond the scope of this study. Prindle and Knopf, however, correlated small areas of schist on Mount Greylock, across the valley of the Hoosic River, with the Rowe Schist of Emerson in the Hoosac Range, and changed the age assignment to Early Cambrian. Large areas of the Taconic Range farther west, across the Green River valley from Mount Greylock, were likewise mapped by Prindle and Knopf as the Rowe Schist.

Larrabee (1939, p. 50) mapped areas of the Taconic Range near Castleton, Vt., as the Rowe, of Early Cambrian age; this unit, however, was not included in his stratigraphic column (p. 48) and the basis of his correlation was not stated.

Herz (1958; 1961) returned to Dale's name Greylock Schist for the Rowe of the Mount Greylock area. MacFadyen (1956) referred to his Mount Anthony Formation the "Rowe Schist in the Taconic Range" of Prindle and Knopf (1932, p. 289) and assigned the rock

to the Middle Ordovician. Hewitt (1961b, p. 32) expanded the Mount Anthony of MacFadyen; the "Rowe Schist of the Taconic Range" is in the upper part of the enlarged formation. Fisher (1961) kept MacFadyen's name but left the problem of the age open. Doll and others (1961) referred the Mount Anthony and contiguous rocks within Vermont to the St. Catherine Formation and assigned to it an Early Cambrian age.

RYSEDORPH CONGLOMERATE

(Ruedemann, 1901a, p. 546)[1]

Moordener kill Bed, Ruedemann, 1901a, p. 548.
Rysedorph Hill Conglomerate, Ruedemann, 1901b, p. 7.
Rysedorph Hill Conglomerate, Ruedemann, *in* Cushing and Ruedemann, 1914, p. 80.
Rysedorph Hill Conglomerate, Ruedemann, 1930, p. 106.
Ryesdorph Conglomerate, Osberg, 1952, p. 116.
Rysedorf Conglomerate, Wilson, 1952, p. 1315.
Rysedorf Conglomerate, Cooper, 1956, Chart 1.
Rysedorph Hill Conglomerate, Sanders and others, 1961, p. 485.
Ryserdorph Conglomerate, Lowman, 1962a, p. 220.
"Blocks-in-shale unit," Berry, 1962, p. 713.

Type locality.—Rysedorph Hill, town of East Greenbush, N.Y. (Troy South 7½-minute quadrangle, New York).

Age.—Trenton.

Remarks.—The name Rysedorph Conglomerate has several variant forms in the geologic literature. Ruedemann used the names Rysedorph and Rysedorph Hill interchangeably. The name Moordener kill refers to a similar rock outcrop in that stream valley near Castleton-on-Hudson (East Greenbush 7½-minute quadrangle, New York), described by Ruedemann (1901a, p. 543), who explicitly correlated it with the Rysedorph (p. 548).

The age of the matrix of this conglomerate at Rysedorph Hill, at Moordener kill, and at Schodack Landing is fixed by Trenton fossils (Ruedemann, 1901b; 1930, p. 112; J. G. Elam, quoted by Berry, 1962, p. 713). Ruedemann (1901a, p. 548) considered the Rysedorph to be within the Normanskill, which was then thought to be Trenton. Later, Ruedemann (1930, p. 113) placed the Rysedorph in the Lower Trenton, about the Normanskill and below the Snake Hill. Fisher (1961, p. D12) placed the Rysedorph within the Snake Hill Formation and stated that "the Rysedorph seems to represent the spalling off of a thrust plate (gravity slide) during its westward travel into the then unconsolidated Snake Hill sediments" (p. D13); the interpretation is nearly identical with that of Zen (1961, p. 313) for the Forbes Hill Conglomerate found within the Hortonville Slate in a comparable tectonic position. The discovery, by Theokritoff and the writer in

[1] See note on p. 95.

May of 1961, of blocks of Taconic rock types, including the Poultney Slate, in a conglomerate outcrop on strike with and only one-fourth of a mile south of Rysedorph Hill (Fisher, 1961, p. D19, stop 1) greatly strengthens the validity of this comparison. A slump block origin for the Rysedorph was, in fact, first proposed by Ruedemann (1942a, p. 120), but he did not specifically connect the event with the emplacement of the Taconic allochthone.

ST. CATHERINE FORMATION

(Doll and others, 1961)

Olive Grit (Unit A)+Roofing Slate (Unit B)+Black Patch Grit (Unit C; in part)+Ferruginous Quartzite (Unit E; in part)+Berkshire Schist (Unit Sb; in part), Dale, 1899, table facing p. 178.

Berkshire Schist (in part), Dale, 1912, pl. 1.

Wallace Slate+Stiles Phyllite (in part)+Bull Slate+Barker Quartzite, Swinnerton, 1922, p. 63, 65, 69, map.

Berkshire Schist, Dale, 1923, pl. 1.

Rowe Schist (of the Taconic Range)+Mettawee Slate+"shales and grits of Lower Cambrian age," Prindle and Knopf, 1932, p. 275–276.

Hubbardton Slate+Stiles Phyllite (in part)+Bull Slate+Barker Quartzite, Keith, 1932, p. 400, 401.

Mettawee Slate+Rowe Schist+Bomoseen Grit+Eddy Hill Grit, Larrabee, 1939, p. 48.

Bomoseen Grit+Mettawee Slate+Schodack Formation (in part)+Zion Hill Quartzite+Bird Mountain Grit+Eddy Hill Grit (in part)+Wallace Ledge Formation, Kaiser, 1945, p. 1085–1089.

Bomoseen Grit+Mettawee Slate+Nassau Formation+Zion Hill Quartzite+Wallace Ledge Slate+Eddy Hill Grit (in part)+Schodack Formation (in part; north of the Castleton River), Fowler, 1950, p. 38–53; also pl. 2.

Zion Hill Quartzite+Wallace Ledge Formation+Eddy Hill Grit+Mettawee Slate+Bomoseen Grit, Billings and others, 1952, p. 36–37.

Mount Anthony Formation, MacFadyen, 1956, p. 28.

Greylock Schist, Thompson, 1959, p. 77.

Mount Hamilton Group (in part)+Bull Formation+Biddie Knob Formation, Zen, 1961, p. 299, 300, 306.

Mount Anthony Formation (in part), Hewitt, 1961b, p. 32.

Type locality.—None specifically given, but presumably refers to the area around St. Catherine Mountain, towns of Poultney and Wells, Vt. (Pawlet 15-minute quadrangle, Vermont).

Original description.—"Purple, gray-green, and variegated slate and phyllite containing minor interbeds of white to green quartzite, locally albitic. Purple and green chloritoid-bearing slate and phyllite; also contains (1) the Bomoseen Greywacke member and (2) the Zion Hill Quartzite member."

Age.—Cambrian(?) and Early Cambrian according to Doll and others (1961). The age assignment is based on fossiliferous beds that occur near the top of the formation.

Remarks.—The name St. Catherine Formation was first used by Shumaker (1960, p. 11), but its first formal publication was by Doll and others (1961). This formation, as shown by Doll and others, includes two large groups of rocks: (a) Rocks that are demonstrably Lower Cambrian or that underlie demonstrated Lower Cambrian rocks without visible stratigraphic break. These rocks tend to occur within the "slate belt" west of the Taconic Range in Vermont, and correspond to Zen's Bull Formation and Biddie Knob Formation as well as their equivalent and correlative strata. (b) Green argillites of the main Taconic Range, with the exception of small areas classified with the Brezee Formation (shown by the symbol Cbrc on the map of Doll and others, 1961). These rocks have not yielded fossils and are separated from the fossiliferous rocks of the adjacent slate belt by major thrust faults. The correlation of these rocks with those of the first group may be subject to revision. This second group of rocks was assigned to the Ordovician by Dale (1899; 1912; 1923), MacFadyen (1956), and Hewitt (1961a; 1961b), and to the Lower Cambrian by Prindle and Knopf (1932), Fowler (1950), Billings and others (1952), Shumaker (1959), and Zen (in press); and left undated by Thompson (1959).

SALISBURY SCHIST

(Dana, 1873, p. 25)

Riga Schist+Everett Schist+Egremont Limestone (in part), Hobbs, 1893, p. 725.

Berkshire Schist+Bellowspipe Limestone, Hobbs, 1897, p. 177.

Berkshire Schist, Gregory and Robinson, 1907, p. 33.

Type locality.—Town of Salisbury, Conn. (Sharon 7½-minute quadrangle, Connecticut-New York).

Original description.—See Agar (1932) for description.

Age.—Originally called "Middle Ordovician or Cincinnatian." The rock may include units that range from Early Cambrian to Middle Ordovician in age.

Remarks.—The term Salisbury Schist was originally used informally by Dana for certain argillites in the neighborhood of Salisbury, Conn. The area was shown by Gregory and Robinson (1907) as the Berkshire Schist; Agar (1932) revived the term Salisbury and gave detailed petrographic descriptions. Rodgers and others (1959) retained the name Salisbury and pointed out that the age and structural relations of the Salisbury Schist are uncertain and the solution of the problems must await studies in adjacent areas in New York and Massachusetts. The Salisbury Schist, as shown by Rodgers and others (1959), is a heterogeneous rock unit, which consists of both black and green schists. These rocks have been metamorphosed; at the east

side of the outcrop area garnet-staurolite gneisses exist (Agar, 1932). The grade of metamorphism is the highest of all Taconic rocks, and this fact is in part responsible for the difficulties in the study of the stratigraphy and structure of these rocks.

SCHAGHTICOKE SHALE

(Ruedemann, 1903, p. 934)

Beekmantown Shale, Dale, 1904, p. 30.
Schaghticoke Beds, Ruedemann, 1947, p. 60.
Germantown Formation (in part), Fisher, 1961, p. D9.
Schaghticoke Formation, Fisher, 1961, p. D22, stop 23.

Type locality.—Gorge of the Hoosic River at the village of Schaghticoke, N.Y. (Schaghticoke 7½-minute quadrangle, New York).

Original description.—"Very fine bedded, black and prevailing dull greenish to olive silicious and argillaceous slates with intercalations of thin limestone beds. The latter, consisting of hard gray, very fine grained limestone, are but about 1 inch thick and separated by black carbonaceous, argillaceous shales."

Age.—Originally referred to the Late Cambrian; the age of the fauna, and therefore of the rock unit, is now considered to be Early Ordovician (Berry, 1962).

Remarks.—The stratigraphic and structural problems of the Schaghticoke Shale at its type locality are multifarious and obscure because of limited knowledge of the rock succession and structure of the area. O'Brien (1960) made a detailed survey of the locality, but his study is limited in scope. Berry (1962) comprehensively restudied the paleontology of this rock unit and discussed the problems of its correlation.

Fisher (1961, p. D9) suggested substitution of the lithostratigraphic name Germantown Formation for the name Schaghticoke at the latter's type locality because the name Schaghticoke has assumed a time connotation; he noted that the Schaghticoke at the type locality is Early Ordovician, but the same rock type may be Late Cambrian farther south in Columbia County, N.Y., and would be mapped as the Germantown Formation. Ruedemann (1903), of course, originally assigned the Schaghticoke to the Late Cambrian because its graptolite fauna is like that of the Tremodac, which was considered as Late Cambrian by British geologists; later, Ruedemann (*in* Cushing and Ruedemann, 1914; Ruedemann, 1930) reassigned the Schaghticoke to the basal Lower Ordovician. This assignment was followed by Fisher, as noted, and also by Berry (1962, p. 698).

Theokritoff (1959a, p. 56) and Berry (1959; 1961, p. 226; 1962, p. 699) suggested the equivalence of the basal Poultney Slate (A-mem-

ber) of the northern Taconic region with the type Schaghticoke on the basis of lithic identity as well as the faunal contents. Other units that may be in part correlative with the Schaghticoke Shale are: the Hatch Hill Formation, the Claverack Conglomerate, the Eagle Bridge Quartzite, the Elizaville Shales, the Mount Hamilton Group, and the Mount Hamilton Formation.

SCHODACK SHALES AND LIMESTONES

(Ruedemann, *in* Cushing and Ruedemann, 1914, p. 69)

*Cambrian Black Shale (Unit D), Dale, 1899, p. 182.
*Hooker Slate, Swinnerton, 1922, p. 74.
*Cambric Black Shale, Ruedemann, 1930, p. 69.
*Hooker Slate+Beebe Limestone, Keith, 1932, p. 402.
*Schodack Formation, Prindle and Knopf, 1932, p. 277.
*Schodack Formation (in part), Resser and Howell, 1938, p. 204.
*Schodack Shales and Limestone, Larrabee, 1939, p. 51.
*Schodack Formation, Kaiser, 1945, p. 1087.
*Schodack Formation, Fowler, 1950 p. 50.
*Schodack Formation, Billings and others, 1952, p. 37 ("in strict sense also called Schodack Shale and Limestone"; but not further defined).
*Hooker Formation, Zen, 1956, p. 1829.
*West Castleton Formation, Zen, 1959, p. 2.
*West Castleton Formation, Zen, 1961, p. 304.
*West Castleton Formation, Doll and others, 1961.
*Hooker? Schodack? or West Castleton? Formation, Fisher, 1961, p. D8.
*Schodack Formation (West Castleton Formation), Lowman, 1961, p. B8.
*Schodak Formation, Lowman, 1962a, p. 221.
*West Castleton Formation, Bird, 1962a, p. 135.
Schodack Shale and Limestone, Ruedemann, 1930, p. 80.
Schodack Formation (in part), Ruedemann, 1942a, p. 62.
Schodack Shale and Limestone, Ruedemann, 1942a, p. 64.
Schodack Formation (in part), Goldring, 1943, p. 64.
Schodack Shale and Limestone, Goldring, 1943, p. 68.
Schodack argillite, black shales, and thin siliceous limestones, Fisher, 1956, p. 341.
Ashley Hill Conglomerate (of the Schodack Shale and Limestone), Craddock, 1957, p. 694.
Schodack Formation, Theokritoff, 1957.
Stuyvesant Conglomerate, Fisher, 1961, p. D6.
Ashley Hill Limestone Conglomerates, Bird, 1962a, p. 135.
Schodack Shale and Limestone, Knopf, 1962, p. 37.

*See p. 76 for explanation of use of asterisk.

Type locality.—New York Central railroad track, Castleton cutoff 2 miles south of Schodack Landing, town of Stuyvesant, N.Y. (Ravena 7½-minute quadrangle, New York).

Original description.—"Black shale or slate, generally weathers blue-black, sometimes pyritiferous, with thin beds of limestone and less frequently limestone breccia" (Ruedemann, *in* Cushing and Ruedemann, 1914, p. 67).

Age.—Early Cambrian.

Remarks.—The use of the name Schodack, as a stratigraphic term, has undergone extraordinary complications even for the Taconic region. Ruedemann (*in* Cushing and Ruedemann, 1914, p. 69) first used the name to refer to Dale's (1899) Cambrian Black Shale of the northern Taconic region. This rock unit was therefore called the Schodack Formation by subsequent workers in the northern area (Kaiser, 1945; Fowler, 1950; Larrabee, 1939; Billings and others, 1952). For details, see section on "West Castleton Formation."

Ruedemann, in 1930 (p. 80), specified that the "Schodack Shale and Limestone" is the Cambrian Black Shale of Dale (1899), "typically his Division I [(Dale, 1904, p. 29)] to which we have added the neutral greenish shale J, that is usually asociated with it." Dale's Unit I is the slate-matrix limestone-pebble conglomerate that occurs, for example, on the west side of Ashley Hill (Dale, 1904, p. 24). The matrix of the conglomerate is a green slate, not black. There is some gray silty slate underlying the conglomerate unit at Ashley Hill and elsewhere in the East Chatham and Nassau quadrangles (Bird, 1962b; T. W. Talmadge, oral communication, 1962; also the writer's own observations); however, this gray slate is lithically distinct from the Cambrian Black Shale and is stratigraphically closely associated with Dale's Unit G (1904, p. 29), which Ruedemann (1930, p. 79) called the Diamond Rock Quartzite. The Diamond Rock and the Ashley Hill are, beyond reasonable doubt, the lithostratigraphic equivalents of the Mudd Pond Quartzite and the North Brittain Conglomerate, respectively, of the northern Taconic region. The Mudd Pond and the North Brittain are both members in the Bull Formation (Zen, 1961). The Bull Formation, in the northern Taconic region, underlies the West Castleton Formation which is Dale's (1899) Cambrian Black Shale (Zen, 1961, p. 304). Ruedemann's (1930) definition of the Schodack, therefore, leaves considerable uncertainty as to the precise rock units involved.

In addition, Ruedemann (1930, p. 80) also gave the Schodack type localities, among which the most explicitly stated are the outcrops along the New York Central railroad tracks, 2 miles south of Schodack Landing. This locality is in the Coxsackie quadrangle and was described in detail by Goldring (1943), who also studied the Lower Cambrian faunal contents of the limestone layers of this outcrop.

Two rock units occur at the Schodack Landing locality. The upper rock unit is a black shale interbedded with brown-weathering calcareous sandstone, much like parts of Fisher's Germantown Formation; the lower rock unit, which Goldring (1943) studied, is a gray-green slate interbedded with intraformational conglomerate of

gray limestone, much like Dale's (1904) Unit I on Ashley Hill. Neither unit resembles the Cambrian Black Shale of Dale; the lower unit (presumably the type Schodack because it contains Lower Cambrian fossils, whereas the upper unit so far has yielded no fossil at all) is lithically especially remote from the Cambrian Black Shale. This discrepancy was first noted by Theokritoff (1957). That Ruedemann did intend the lower unit at Schodack Landing as the type Schodack Shale and Limestone is further proved by his designating Dale's Unit I as the typical lithology.

The name Schodack, in its simplest acceptation, therefore, has a double meaning. Ruedemann may have been influenced, in his designation of type locality, by the fact that the Cambrian Black Shale of Dale (1899) and the rocks at Schodack Landing both yielded the same Lower Cambrian fauna. We now know, however, that even in the northern Taconic region the fauna of the North Brittain Conglomerate and of the overlying West Castleton Formation are practically identical (Lochman, 1956; Theokritoff, 1959b); hence, for lithologic mapping such as was done by Dale (1899; 1904) and Ruedemann (*in* Cushing and Ruedemann, 1914; Ruedemann, 1930; 1942a), the fossils are not diagnostic of formations. This fact is also evident from a perusal of the work of Schuchert (1937).

For the purpose of compiling a synonymy, therefore, two sets of names are needed: one set of names that refers to the "Cambrian Black Shale" of Dale, originally named the Schodack Shales and Limestones by Ruedemann and applied specifically to the northern Taconic region; and one set of names that refers to the rocks at Schodack Landing, which carry the *Elliptocephala asaphoides* fauna and constitute the type locality of the Schodack Shales and Limestones of Ruedemann. Asterisks have been used in the synonymy on page 74 to indicate the first set. It is important to realize, however, that the two sets of names may overlap in the ranges of rocks encompassed, because different works include different units under a given name.

Fischer (1961) used the name Schodack in the Troy, N.Y., area, in the same sense as has been used in the northern Taconic region, namely, the "Cambrian Black Shale" of Dale, and not in the sense of the Schodack at Schodack Landing. Fisher's usage was also adopted by Lowman (1961, p. B8) for the Troy area, because he specified that the Schodack is the West Castleton Formation. Lowman (1962a, p. 221) used the name at least in part in the same sense, although for lack of stratigraphic details this point is not certain.

The vicissitudes of the name Schodack have been reviewed by Theokritoff (1957; 1963). Fisher (1961, p. D8) also summarized the problem. Fisher pointed out that at Judson Point in the Cox-

sackie quadrangle (Hudson North 7½-minute quadrangle) *Atops trilineatus* and *Elliptocephala asaphoides* have recently been found, and he stated that "this, disconcertingly, is the same unit that overlies the fossiliferous Mettawee [=Schodack of Ruedemann] at Schodack Landing and therefore, ironically, Ruedemann was indeed correct!" The rock in question was mapped by Goldring (1943, p. 61) as the Nassau Beds. Several rock types occur at Judson Point, but none of these can be demonstrated now as equivalent to either rock unit at Schodack Landing. Moreover, Fisher (1961) did not specify the rock unit at Judson Point that yielded the fossils. Detailed mapping of the Judson Point area is urgently needed.

Ruedemann (1942a, p. 64) and Goldring (1943, p. 55), following Resser, enlarged the scope of the name Schodack to include not only the original "black shales and limestones," but also the Zion Hill Quartzite, the Burden Iron Ores, and the "Burden Conglomerate of Grabau". This enlarged unit was called the Schodack Formation; however, Ruedemann (1942a, p. 63) did not include the name in his table of stratigraphic units.

Resser and Howell (1938, p. 204) used the name Schodack Formation to refer to Dale's (1899) "Cambric [sic] Black Shales", but added that the Mettawee Slate may be also part of the Schodack. In addition, these authors mentioned that their Schodack Formation "consists of thin bedded limestone or dolomitic limestone, in varying alternations with black or greenish shale and calcareous quartz sandstone"; this description suggests that more rock types of the Bull Formation, and possibly even some of the Hatch Hill Formation and the Poultney Slate, are included. The usage is inconsistent even with Resser's suggestion quoted by Ruedemann (1942a, p. 64), because the Mettawee Slate is the lithic equivalent of the Nassau Beds (Ruedemann, 1942a) that underlie Resser's enlarged "Schodack Formation." The expanded definition was not adopted by Howell and others (1944, col. 69) in their Cambrian correlation chart.

Billings and others (1952, p. 37) used the name Schodack Formation to refer to Dale's Cambrian Black Shale, in conformity with the then prevailing usage in the northern Taconic region, but added that "in strict sense [the rock is] also called Schodack Shale and Limestone"; this term, however, at the type locality referred to the underlying unit, as we know now. Theokritoff (1957) referred to the Schodack Formation when apparently he intended to discuss the Schodack Shales and Limestones of the Schodack Landing outcrop.

SNAKE HILL SHALES

(Ruedemann, 1912, p. 59)

Snake Hill Beds, Ruedemann, 1912, p. 58.
Snake Hill Formation, Ruedemann, *in* Cushing and Ruedemann, 1914, p. 93.
Snake Hill Shale, Twenhofel and others, 1954, chart 2.
Snake Hill Formation, Fisher, 1961, p. D12.
Snake Hill Shale, Berry, 1962, p. 713.

Type locality.—Snake Hill, east shore of Lake Saratoga, town of Saratoga, N.Y. (Schuylerville 15-minute quadrangle, New York).

Original description.—Dark-gray to black, bluish and greenish gray argillaceous shale; it possesses a conglomerate, locally grit, and some thin sandy bands and intercalations of sandy limestone and gray crystalline limestone as much as half a foot thick (Ruedemann, *in* Cushing and Ruedemann, 1914, p. 94).

Age.—Trenton.

Remarks.—Although the name Snake Hill was first used by Ulrich (1911, pl. 27), its formal introduction was made by Ruedemann. The lithic designation, Snake Hill Shale, is adopted by Twenhofel and others (1954, chart 2, columns 14, 18). Kay (1937, p. 272) indicated the equivalence of the Snake Hill with the Canajoharie Shale; Keith (1932, p. 369) suggested the equivalence of the Snake Hill with the Hortonville Slate. Both suggestions are generally accepted today.

The Snake Hill Shales are Trenton in age (Kay, 1937) and are locally in contact with the Taconic rocks that are thrust over the Snake Hill. The structural relations, as well as the broad lithic similarity and scanty faunal evidence, indicate that the following autochthonous formations, mentioned in this paper, are probably correlative with the Snake Hill: The Hortonville Slate, the Benson Slate, the Ira Formation, the Walloomsac Slate (at least in part), parts of the Mount Anthony Formation of Hewitt, parts of the Berkshire Schist, parts of the Salisbury Schist, and the Riga Schist. Zen (1961) suggested the contemporaneity of the Snake Hill or its equivalents in the autochthone with the Pawlet Formation (= the Austin Glen) in the allochthone. A. S. Warthin, Jr., (oral communication, 1959) indicated the partial lateral-facies equivalence of the Snake Hill with the post-Balmville (Holzwasser, 1926) Mount Merino and Austin Glen beds of the autochthone in the vicinity of Poughkeepsie, N.Y.; Ruedemann (*in* Cushing and Ruedemann, 1914, p. 95) and W. B. N. Berry (written communication, 1961) found that the type Snake Hill contains graywacke beds similar to those of the Austin Glen. Berry (1963) now urges that the name Snake Hill be abandoned for the rock unit altogether.

STILES PHYLLITE

(Swinnerton, 1922, map; Keith, 1932, p. 400)

Berkshire Schist (Unit Sb; in part), Dale, 1899, p. 191.
Berkshire Schist (in part), Dale, 1912, pl. 1.
Mettawee Slate+Schodack Formation (in part), Kaiser, 1945, p. 1085, 1087.
Mettawee Slate+Schodack Formation, Fowler, 1950, p. 47, 50.
Mettawee Slate+Schodack Formation, Billings and others, 1952, p. 37.
Biddie Knob Formation+Bull Formation, Zen, 1961, p. 299, 300.
St. Catherine Formation, Doll and others, 1961.

Type locality.—Stiles Mountain (not to be confused with the nearby Stiles Hill), town of Sudbury, Vt. (Sudbury 7½-minute quadrangle, Vermont).

Original description.—"Slate or phyllite, with fairly numerous thin beds of quartzite. The whole formation, including the quartzite beds, has a rather plain greenish aspect due to secondary chlorite. This color is modified on weathered surfaces so as to become a greenish-gray or whitish gray. Much quartz in thin lenses and veins appear in this formation, especially in its eastern areas" (Keith, 1932, p. 400).

Age.—Called Early Cambrian by Keith (1932, p. 361); the rock has not yielded fossils but underlies Early Cambrian units in a conformable sequence. The age is therefore Cambrian(?).

Remarks.—The areal extent of the Stiles Phyllite, shown by Swinnerton and by Keith, is nearly coincidental with the area of Berkshire Schist of Dale (1899; 1912), except that black phyllite at the north end of the Taconic Range was mapped by Keith as his Brezee Phyllite, and that on the east flank of the Taconic Range was mapped as "black slate of West Rutland Valley" by Swinnerton and as the Ira Slate by Keith. These black slate areas were included in the Berkshire by Dale.

Swinnerton and Keith also interpreted the western contact of the Stiles against the underlying rocks as a thrust fault rather than an unconformity, as did Dale (1899). Kaiser (1945) mapped the area as consisting of the Mettawee Slate and the Schodack Formation; in the Schodack he included the Ira Slate of Keith. Kaiser's contact cannot be verified by field check. Kaiser's map was virtually adopted intact by Fowler (1950), except that Fowler assigned part of Kaiser's Schodack to the autochthone and called it the Hortonville Slate. Zen (1959; 1961) assigned the area of the Stiles Phyllite chiefly to his Biddie Knob and Bull Formations, but separately mapped the black slate as the West Castleton Formation and the Ira Formation. The western limit of the Stiles Phyllite was not recognized by Zen as a break in either stratigraphy or structure. Stiles Mountain itself was shown by Zen as underlain by the Mettawee Slate, part of his Bull Formation.

STUYVESANT CONGLOMERATE

(Fisher, 1961, p. D6)

Stuyvesant Primordial Beds, Ford, 1885, p. 16.
Schodack Shales and Limestones, Ruedemann, *in* Cushing and Ruedemann, 1914, p. 69.
Schodack Shale and Limestone, Ruedemann, 1930, p. 80.
Schodack Shale and Limestone, Goldring, 1943, p. 68.
Schodack Formation, Theokritoff, 1957.

Type locality.—Town of Stuyvesant, about 2 miles south of Schodack Landing, N.Y. (Ravena 7½-minute quadrangle, New York).

Original description.—"A persistent limestone brecciola, 5–20 feet thick, * * * an ill-sorted heterogeneous mixture of slabby coarse to fine textured limestone in an argillaceous or quartz-sand matrix—the quartz grains usually well rounded."

Age.—Early Cambrian (*Elliptocephala asaphoides* fauna).

Remarks.—The name Stuyvesant was not included in Wilmarth's Lexicon (1938). Ford used the name informally, but Fisher formalized it, apparently to remedy the confusion connected with the name Schodack. A comparison of the map and description of Ford (1885, p. 17) with those of Goldring (1943) shows beyond doubt that Ford's outcrops are the type Schodack at or near the New York Central railroad tracks.

Fisher stated that the Stuyvesant is in the Mettawee Slate; presumably he referred to the upper part of the Mettawee but gave no stratigraphic details. Fisher noted the near identity of the fossils of the Stuyvesant with those on the Ashley Hill Limestone Conglomerate. The comparison of the two rocks was earlier made by Dale (1904, p. 16) and Goldring (1943, p. 70). For further details, see the section on "Ashley Hill."

STUYVESANT FALLS FORMATION

(Fisher, 1961, p. D9)

Normanskill Formation+Nassau Beds (in part?), Goldring, 1943, map 1.
Deepkill Interbedded Shale and Quartzite Unit, Craddock, 1957, p. 685.
Elizaville Shales (in part?), Weaver, 1957, p. 749.

Type locality.—Kinderhook Creek, under the bridge of Columbia County Route 25A in Stuyvesant Falls, town of Stuyvesant, N.Y. (Stottville 7½-minute quadrangle, New York).

Original description.—"Interbedded green silty shale and flow-cast green siltstones and chertified argillite."

Age.—Late Cambrian and Early Ordovician. (See also Berry, 1962, p. 709.)

Remarks.—Fisher defined the Stuyvesant Falls Formation as a lithostratigraphic unit, of Late Cambrian to Early Ordovician age, overlying the Germantown Formation (1961, p. D9) and underlying the Mount Merino Shale of his Normanskill Group (1961, p. D9). The type Stuyvesant Falls is a distinctive rock unit. It was mapped by Craddock (1957) as a lithic unit in the Deepkill succession; the contiguous region in the Coxsackie quadrangle to the west, however, was shown by Goldring (1943) as largely underlain by the Normanskill, and some, possibly, as underlain by the Nassau Beds. As a lithic unit, the Stuyvesant Falls is easily equated with rocks elsewhere in the Taconic sequence. An isolated outcrop at St. Andrew-on-the-Hudson near Hyde Park, N.Y., shown to the writer and W. B. N. Berry by A. S. Warthin Jr., in 1959, may be the Stuyvesant Falls. In the northern Taconic region, the Stuyvesant Falls-equivalent is the bulk of the Poultney Slate (Keith, 1932, p. 403; Theokritoff, 1959b; Zen, in press), called the Poultney B-member by Theokritoff (written communication, 1960), although the Poultney C-member perhaps should be included in this equation on lithological ground. The biostratigraphic and lithostratigraphic evidence, however, is conflicting because, though Fisher (1961, p. D9) implied that the upper limit of the Stuyvesant Falls coincides with the base of the Normanskill, Berry (1961, p. 226) showed that fossils of zones 7–10 of his Marathon graptolite succession, corresponding to the upper Deepkill of New York, are so far unknown in the Poultney Slate, whereas forms of the *Nemagraptus gracilis* or possibly even of the *Climacograptus bicornis* zone (zones 11 and 12, respectively, of the Marathon region) are found in rocks assigned to the top of the Poultney on lithic grounds. The Poultney, therefore, may well include beds traditionally relegated to the Normanskill on faunal basis. Whether this conflict is due to a real lateral facies change, to a confusion of rock types in the field, or to an incomplete faunal record, cannot be determined.

TACKAWASICK LIMESTONE

(Ruedemann, 1929, p. 410)

Stockbridge Limestone (in part), Dale, 1892, p. 312.
Tackawasick Limestone and Shale, Ruedemann, 1930, p. 115.
Tackawasick Calcareous Shale, Ruedemann, 1930, geologic map.
Trenton Limestone of the Coonradt Farm, Balk, 1953, p. 819.
Balmville Limestone, Fisher, 1961, p. D2.

Type locality.—Knob 860 feet high one-half mile east of Tackawasick Lake, town of Nassau, N.Y. (Nassau 7½-minute quadrangle, New York).

Original description.—"[A] bluish and light gray limestone [which according to J. E. Wolff is] composed of grains of crystalline calcite

with little specks of black iron oxide and numerous clear grains almost all feldspar" (Dale, 1892, p. 311).

"Thin-bedded shaly gray limestone, the beds about one inch thick with interbedded one-fourth inch dolomitic layers, and some 20 feet of interbedded greenish argillite" (Ruedemann, 1930, p. 115).

Age.—Trenton.

Remarks.—The Tackawasick Limestone is fossiliferous (Dale, 1892, p. 311; Ruedemann, 1930, p. 116) and lithologically comparable with the limestone commonly found at the base of the autochthonous Trenton black slate, such as the Hortonville, the Walloomsac, and the Snake Hill. Structurally, however, the Tackawasick is located between the Nassau Beds of Ruedemann (1930; = Nassau Formation in part, Bird, 1962a) and the Rensselaer Graywacke. This position would be consistent with a hypothesis of normal superposition if the Rensselaer were Siluro-Devonian (see section on "Rensselaer Graywacke" for details); but if the Rensselaer were pre-Ordovician, as seems to be the consensus of modern workers (Balk, 1953; Craddock, 1957; Bird, 1962a), the position of the Tackawasick would be anomalous. Bucher's (1957, p. 663) suggestion that the Tackawasick is a synclinal outlier is similar to Craddock's interpretation of comparable Ordovician carbonate rocks in the towns of Chatham and Ghent in the Kinderhook quadrangle (1957, p. 696). Other workers (Balk, 1953, pl. 1, section 30; Bird, 1962b; T. W. Talmadge, written communication, 1962), however, interpret the Tackawasick as a sliver caught under the western margin of a thrust fault underlying the Rensselaer Plateau; this interpretation seems to conform better with regional patterns.

Lower to Middle Ordovician limestone and dolostone are also found within the Taconic sequence in the following towns in Vermont: in Ira (Fowler, 1950, p. 31; Zen, 1961, pl. 1; also in press), Tinmouth (Dale, 1912, pl. 1; Gordon, 1924, p. 245; Shumaker, 1960; Doll and others, 1961), and Pawlet (Gordon, 1924, p. 248; Shumaker, 1960; Billings and others, 1952; Doll and others, 1961). Platt (1960) reported slivers in the Cossayuna quadrangle, New York, in front of the Taconic thrust sheet; the Bald Mountain Limestone in Greenwich, N.Y., holds a similar position. All these rocks may be similar in origin to the Tackawasick Limestone.

TROY SHALE

(Ruedemann, *in* Cushing and Ruedemann, 1914, p. 70)

Unit H, Dale, 1904, p. 29.
Troy Shales and Limestones, Ruedemann, 1930, p. 82.
Mettawee Slate(?), Billings and others, 1952, p. 37.
Schodack Shale and Limestone, Craddock, 1957, p. 694.

Mettawee Shales and "Schodack" black shales and limestones, Fisher, 1961, p. D8.
Nassau Formation (in part), Bird, 1962a, p. 135.

Type locality.—Dam in the Poesten kill below Mt. Ida Lake and in the Poestenkill Gorge, Troy, N.Y. (Troy South 7½-minute quadrangle, New York).

Original description.—"25 to 100 feet of colored shales with small beds of calcareous quartzite."

Age.—Originally assigned to the Early Cambrian by Ruedemann. Dale's Unit H (1904) certainly underlies fossiliferous Lower Cambrian rocks at Ashley Hill (Unit I, Dale, 1904) in a conformable sequence. If, in addition, the Diamond Rock Quartzite (Ruedemann, *in* Cushing and Ruedemann, 1914, p. 70) proves to be Dale's (1904) Unit G, then an Early Cambrian age for Dale's Unit H would be established because the Diamond Rock is also fossiliferous. The stratigraphic relation between Ruedemann's type Troy Shale and Dale's 1904 succession, however, is still obscure. The problem is not resolved by Elam's (1960) detailed mapping in the Troy area.

Remarks.—Ruedemann's Troy Shale has not been adequately defined. On the basis of its stratigraphic position as originally stated by Dale (1904, p. 29), it is below the limestone conglomerate of Ashley Hill (Unit I), and therefore is part of Craddock's Schodack Shale and Limestone, which includes Unit G of Dale (1904). Fisher (1956, p. 344) and Elam (1960, p. 38) adequately summarized the problems and uncertainties of the name Troy Shale; Fisher (1961, p. D8) suggested that the rock may be parts of his Mettawee and the "Schodack." Billings and others (1952, p. 37) surmised an equivalence of the Troy with the Mettawee; Bird (1962a, p. 135) and T. W. Talmadge (written communication, 1961) put Dale's Unit H, and therefore the Troy Shale, in the upper part of Bird's enlarged Nassau Formation; as such it becomes equivalent to the upper part of the Mettawee Slate Facies of the Bull Formation (Zen, 1961).

WALLACE LEDGE FORMATION

(Kaiser, 1945, p. 1089)

Cambrian Roofing Slate (Unit B; in part), Dale, 1899, p. 180.
Wallace Slate, Swinnerton, 1922, p. 63.
Hubbardton Slate, Keith, 1932, p. 401.
Wallace Ledge Slate, Fowler, 1950, pl. 2.
Mettawee Slate Facies of the Bull Formation (in part)+Biddie Knob Formation (in part), Zen, 1961, p. 299, 300.
St. Catherine Formation (in part), Doll and others, 1961.

Type locality.—Wallace Ledge, town of Castleton, Vt. (Bomoseen 7½-minute quadrangle, Vermont).

Original description.—"The lower part of [this layer of colored slate] is gritty purplish slate; the upper part, as exposed beneath

the quartzite on the cliffed western side of Wallace Ledge, is a soft green slate with some purple."

Age.—Early Cambrian according to Kaiser (1945, p. 1084); the rock has not yielded fossils but does underlie Early Cambrian rocks in a conformable sequence. The age, therefore, is Cambrian(?).

Remarks.—Kaiser's description of the two parts of the Wallace Ledge Formation corresponds to the Biddie Knob and Mettawee lithologies, respectively, of Zen (1961); the grittiness is undoubtedly due to the tiny chloritoid crystals. Kaiser thought that the Wallace Ledge underlies the Zion Hill Quartzite and overlies the Schodack Formation in normal succession; he was obliged to establish the Wallace Ledge as a formation distinct from the Mettawee, because he considered that normally the Zion Hill quartzite lies directly on the black Schodack Slate (Kaiser, 1945, p. 1089). This error is ultimately due to Dale (see sections on "Hatch Hill Formation" and on "Zion Hill Quartzite"). With the recognition of a more nearly correct stratigraphy and of a thrust contact between the Zion Hill and the Schodack (=West Castleton) in the critical area between Zion Hill and Crystal Ledge southeast of the village of Bomoseen (Zen, 1961, p. 314), the Wallace Ledge becomes part of the Mettawee Slate.

WALLOOMSAC SLATE

(Prindle and Knopf, 1932, p. 274)

Berkshire Schist (in part), Dale, 1912, pl. 1.
Berkshire Schist (in part), Dale, 1923, pl. 1.
Walloomsac Shale, Ruedemann, 1942a, p. 136, 173, 174.
Wallumsac Shale, Ruedemann, 1942c, p. 57.
Hortonville Formation, Doll and others, 1961.
Mount Anthony Formation (in part), Hewitt, 1961b, p. 32.
Walloomsac Formation, Hewitt, 1961b, p. 39.

Type locality.—Walloomsac River west and northwest of Bennington, Vt. (Hoosick Falls 7½-minute quadrangle, Vermont-New York),

Original description.—"A thick series of dark smooth shales and soft slates [resting] conformably upon the uppermost dark blue crinoidal limestone" (Prindle and Knopf, 1932, p. 274). "[The rock is typically] a black, graphitic, sericite phyllite, [but] occassionally contains thin, sandy laminae" (MacFadyen, 1956, p. 27).

Age.—Upper Normanskill (graptolite fauna); the rock is continuous on the ground with the slates of the Ira formation which are lithically identical. The Ira is Trenton (shelly fauna).

Remarks.—The geologic maps accompanying Dale's 1912 and 1923 studies do not include the type locality of the Walloomsac Slate. However, the equivalence of the lower part of Dale's Berkshire Schist to the Walloomsac is made clear by comparing Dale's maps with those of Prindle and Knopf and of MacFadyen (1956).

Prindle and Knopf proposed that the Walloomsac Slate is correlative with upper Normanskill Shale. This correlation is further indicated by recent finds of graptolites by D. B. Potter (written communication, 1962), identified as of the *Climacograptus bicornis* fauna by W. B. N. Berry (oral communication, 1962), in rocks near the type locality. On the ground, the Walloomsac is continuous northward into the Ira Formation of the Pawlet quadrangle (Thompson, 1959) and of Ira, Vt. (Zen, 1961); and southward into the black units of the Berkshire Schist of Emerson (1917) and of Dale (1923), and into the Riga Schist of Hobbs (1893). The equivalence and probable correlation of these units is fairly assured. MacFadyen (1956, p. 28) cited the correlation of the Walloomsac with the Hortonville Slate. Correlation of the Walloomsac with part of the Normanskill of the Taconic sequence (Austin Glen lithology) was suggested by Potter (1959) and Zen (1960); Berry's work (1962) suggests, however, that at least parts of the Walloomsac may be correlative with the Mount Merino.

Hewitt (1961b) included both the Walloomsac and the Mount Anthony of MacFadyen in his enlarged Mount Anthony Formation; in this usage the name becomes a synonym of Dale's (1912) Berkshire Schist.

Fisher (1961) extended the name Walloomsac Slate to outcrops in the Copake and Kinderhook quadrangles for rocks previously mapped as Trenton black shales by Craddock (1957) and Weaver (1957). Craddock suggested this extension of name (1957, p. 697), asserting the continuity of the rocks on the ground; the continuity, however, was not accepted by Fisher (1961, p. D3). The Copake-Kinderhook area of black slate is in a different structural belt from the type Walloomsac, and the two belts are possibly separated by large-scale dislocations (Fisher, 1961, p. D3).

WEST CASTLETON FORMATION

(Zen, 1961, p. 304)

Cambrian Black Shale (Unit D), Dale, 1899, p. 182.

Schodack Shales and Limestones, Ruedemann, *in* Cushing and Ruedemann, 1914, p. 69.

Hooker Slate, Swinnerton, 1922, p. 74.

Hooker Slate+Beebe Limesteone+Brezee Phyllite (in part), Keith, 1932, p. 399, 402.

Schodack Shales and Limestone, Larrabee, 1939, p. 51.

Schodack Formation, Kaiser, 1945, p. 1087.

Schodack Formation, Fowler, 1950, p. 50.

Schodack Shales and Limestones, Billings and others, 1952, p. 37.

Hooker Formation, Zen, 1956.

Brezee Formation (in part)+West Castleton Formation, Doll and others, 1961.

Type locality.—Road cut along Scotch Hill Road south of the village of West Castleton, town of Castleton, Vt. (Bomoseen 7½-minute quadrangle, Vermont).

Original description.—"The West Castleton Formation ranges from a dark gray, hard, poorly cleaved, sandy or cherty slate that weathers white or pale red to a jet-black, fissile, graphitic and pyritic slate that contains many paper-thin white sandy laminae and commonly also black cherty nodules, and when weathered displays much alum bloom. Locally interbedded * * * are beds of buff- to yellow-weathering black dolostone or dolomitic quartzite. * * * [The Beebe Limestone Member is] a black, fine-grained, massive limestone, weathering dark gray and abundantly crisscrossed with calcite veins; * * * it may be as much as 20 feet thick but is commonly absent."

Age.—Early Cambrian (the *Elliptocephala asaphoides* fauna).

Remarks.—Ruedemann (*in* Cushing and Ruedemann, 1914) named this unit, Dale's Cambrian Black Shale, of western Vermont and Washington County, N.Y., the Schodack Shales and Limestones. The name Schodack Formation later came into general usage in the northern Taconic region. Theokritoff (1957) pointed out the error in naming, as fully discussed under the section on Schodack Shales and Limestones. Swinnerton (1922) named the Lower Cambrian black slate in the vicinity of Castleton, Vt., the Hooker Slate. This usage was followed by Keith (1932), who at the same time also named a Lower Cambrian black phyllite unit at the north end of the Taconic sequence the Brezee Phyllite. Zen (1961) mapped these two as a single unit, the West Castleton Formation, although part of Keith's Brezee was assigned to the younger Mount Hamilton Group and the Ira Formation. The type Hooker Slate is unfossiliferous and in part resembles the Ordovician Poultney Slate; its stratigraphic position is therefore debatable. For these reasons, Zen suggested the name West Castleton to substitute for the name Hooker. The type locality of the West Castleton is fossiliferous (Swinnerton, 1922, p. 77–79; Schuchert, 1937, p. 1039; Zen, 1961, p. 305) and displays clearly the stratigraphic and structural relation of the unit to both the underlying and overlying rocks.

Zen (1961) mapped areas of black slate peripheral to the north and east sides of the Taconic sequence as West Castleton(?)—Mount Hamilton(?)—Ira(?) and as West Castleton(?)—Mount Hamilton(?). The uncertainties in classification arise from the fact that in these areas (chiefly in Sudbury and Brandon towns) black slate outcrops occur that locally include (1) blue-grey limestone characteristic of the Beebe Limestone Member of the West Castleton Formation, (2) punky-weathering calcareous quartzite characteristic of the Hatch

Hill Formation, and (3) the Forbes Hill Conglomerate of the Ira (or Hortonville) Slate. For these reasons, all the various black slate units are believed to be present in the area, yet the black slates cannot readily be mapped separately in the field.

Doll and others (1961) showed these areas of black slate of questionable classification as the Brezee Formation, which was interpreted as underlying all the other units of the Taconic sequence in this area. Because of the local presence of the Forbes Hill Conglomerate, however, part of this area is certainly Ordovician in age. These areas of Ordovician rocks may prove to be more extensive than was shown by Zen (1961). At least one outcrop area, near Keeler Pond, included by Doll and others in their Brezee Formation, is a limestone lithically identical with the Beebe Limestone of the West Castleton Formation, and contains Lower Cambrian fossils (Zen, 1961, p. 305). The name Brezee Formation is discussed elsewhere in this study; its use for rocks at the north end of the Taconic sequence has been further analysed by Zen (1963) and by Doll and others (1963).

Lower Cambrian black slates, which in lithology and in stratigraphy correspond to the West Castleton Formation, are widely recognized in the Taconic belt. These rocks have been called the Schodack Shales and Limestones (Ruedemann, *in* Cushing and Ruedemann, 1914, p. 69; Ruedemann, 1930, p. 80; 1942a, p. 63 (=part of the Schodack Formation, p. 62); Goldring, 1943, p. 68 (=part of the Schodack Formation, p. 64); Craddock, 1957, p. 694) and the Schodack Formation (Prindle and Knopf, 1932, p. 277; Fisher, 1956, p. 341), among other names. The problem of Schodack nomenclature has been discussed; because of the stratigraphic ambiguity of the name "Schodack," recent workers have tended to shy away from it. Potter (1959) referred to the rocks without using a name; Bird (1962a, p. 136) used the name West Castleton; and Fisher (1961, p. D8) referred to the "Schodack? Hooker? or West Castleton? Formation." Platt (1960), in the Cossayuna quadrangle, Elam (1960), in the Troy South and East Greenbush quadrangles, and T. W. Talmadge (written communication, 1961), in the East Chatham quadrangle, all in New York, also recognized rock-stratigraphic units corresponding to the West Castleton Formation.

ZION HILL QUARTZITE AND GRAYWACKE MEMBER (OF THE BULL FORMATION)

(Zen, 1961, p. 302)

Quartz Conglomerate of the Berkshire Schist, Dale, 1892, p. 237 (=Bird Mountain Grit of Dale, 1900).

Ferruginous Quartzite (Unit E; in part), Dale, 1899, p. 183.

Bird Mountain Grit, Dale, 1900, p. 15.

Zion Hill Quartzite, Ruedemann, *in* Cushing and Ruedemann, 1914, p. 70.
Barker Quartzite, Swinnerton, 1922, p. 65.
Barker Quartzite, Keith, 1932, p. 401.
Zion Hill Formation+Bird Mountain Grit, Kaiser, 1945, p. 1089, 1090.
Zion Hill Quartzite+Bird Mountain Grit (of the Nassau Formation), Fowler, 1950, p. 41, 53.
Zion Hill Quartzite, Billings and others, 1952, p. 36.
Zion Hill Quartzite Member of the St. Catherine Formation, Doll and others, 1961.

Type locality.—Zion Hill, town of Hubbardton, Vt. (Bomoseen 7½-minute quadrangle, Vermont).

Original description.—"Predominantly [the rock is] a massive, green to grayish green, vitreous, chloritic quartzite but ranges to graywacke. Besides chlorite and quartz, the rock contains much muscovite, alkali feldspars, pyrite now altered to limonite, and rare graphite flakes. The rock weathers to a rough surface but is glistening white at a distance. Grain size varies considerably. The base of the rock is commonly a conglomerate, at places a few feet thick and interbedded with the Mettawee Slate. The conglomerate contains pebbles of slate, limestone, and fresh, angular crystals of feldspar, quartz, and muscovite. The pebbles may be up to 3 inches across but more commonly are less than a quarter of an inch. Most of the rock is massive and contains well-sorted quartz grains, and minor feldspar. Graded bedding is not uncommon. The highest beds are locally fine-grained and grade into a mudstone."

Age.—Called Early Cambrian by various workers, the rock has not yielded fossils but is in a conformable sequence with the overlying fossiliferous Early Cambrian North Brittain Conglomerate. The age is, thus, properly Cambrian(?).

Remarks.—The one major local stratigraphic problem for the Zion Hill is due to Dale's conclusions. Dale correlated the Ferruginous Quartzite as typified by outcrops at Zion Hill, Wallace Ledge, and other places with a calcareous sandstone that is now referred to the Upper Cambrian Hatch Hill Formation (for details, see section on "Hatch Hill Formation"). In addition, Dale assigned the quartzitic rocks of Zion Hill to a stratigraphic position above his Cambrian Black Shale; the contact, however, is now shown to be a thrust fault (Zen, 1961, p. 314; see "Wallace Ledge Formation" for further comments).

Dale (1900, p. 21) considered the Bird Mountain Grit as post-Chazyan in age and correlated it with the Rensselaer Grit of Rensselaer County, N.Y. (1892, p. 337). Fowler (1950, p. 45) suggested that the Bird Mountain Grit, which he mapped as a facies of the Nassau Formation, is possibly Precambrian and therefore older than

the Zion Hill Quartzite (1950, p. 54). Other workers, however, (Keith, 1932, p. 401; Kaiser, 1945, p. 1090; Zen, 1961, p. 303; also in press), equated the Bird Mountain Grit (or graywacke) with the Zion Hill.

The Zion Hill lithology corresponds to Units B and D of Dale's (1904, p. 29) Rensselaer County succession. These rocks were mapped as part of the Nassau Beds by Ruedemann (*in* Cushing and Ruedemann, 1914, p. 70; Ruedemann, 1930, p. 79; 1942a, p. 38), Goldring (1943, p. 56), and Fischer (1956, p. 337), and apparently as part of the Rensselaer Graywacke and Quartzite by Craddock (1957, p. 692). Fischer (1961, p. D6) called Dale's Units B and D the Curtiss [sic] Mountain Quartzite, and gave its type locality as Curtis Mountain (Dale, 1904, p. 22), but called the surrounding slate the Elizaville Shale, a name used by Weaver (1957, p. 739) for a supposedly Upper Cambrian to Lower Ordovician slate sequence. Fisher suggested the partial equivalence of the Elizaville with the Mettawee and the Nassau. The Curtis Mountain and the Rensselaer are now both referred to an expanded Nassau Formation by Bird (1962a, p. 135).

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NOTE:—Ruedemann did not make clear whether he intended the name Rysedorph Conglomerate to apply to the calcareous sandstone matrix, limestone-pebble conglomerate as exposed on top of Rysedorph Hill, or to apply to the black slate-matrix conglomerate whose boulders, as we now know, include the conglomerate outcrop on Rysedorph Hill. Ruedemann's (1901b, p. 7, 101) lithic description for this outcrop, and his description (1901a, p. 544) for the outcrop in the Moordener kill gorge, both refer to the calcareous sandstone matrix conglomerate. However, in another paper Ruedemann stated (*in* Cushing and Ruedemann, 1914, p. 80–81) that the conglomerate at Bald Mountain, N.Y., "consists of a black mud matrix," and identified this rock with the "Rysedorph Hill conglomerate"; on another page (1914, p. 83) he reported that this same conglomerate has a matrix "which consists, as at Rysedorph Hill, largely of sandy lime." Ruedemann's usage, thus, is not consistent. In this paper, however, the name Rysedorph has been applied to the slate-matrix conglomerate whose boulders include the conglomerate on top of Rysedorph Hill. I am indebted to J. M. Bird for calling my attention to this discrepancy. (Ref. p. 70.)

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