Contributions to Stratigraphy 1964

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UNITED STATES DEPARTMENT OF THE INTERIOR

STEWART L. UDALL, *Secretary*

GEOLOGICAL SURVEY

Thomas B. Nolan, *Director*

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[Letters designate the separately published chapters]

Changes in Stratigraphic Nomenclature by the U.S. Geological Survey, 1963

By GEORGE V. COHEE *and* WALTER S. WEST

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CHANGES IN STRATIGRAPHIC NOMENCLATURE BY THE U.S. GEOLOGICAL SURVEY, 1963

By George V. Cohee and Walter S. West

ABSTRACT

This publication is the first in a series of annual reports that will make data available regarding changes in stratigraphic nomenclature and that will list publications in which the changes have been described.

The Geologic Names Committee, first organized in 1899, is responsible to the U.S. Geological Survey for defining and recommending policy and rules governing stratigraphic nomenclature. The Committee maintains records which include an index to the work of the Committee and an index to the stratigraphic literature of the United States as far as names and classification are concerned.

Since 1890, U.S. Geological Survey reports have followed rules of nomenclature and classification which have been modified from time to time. The history of these rules is traced. The Survey, through the Geologic Names Committee, is now operating under the "Code of Stratigraphic Nomenclature" prepared in 1961 by the American Commission on Stratigraphic Nomenclature.

INTRODUCTION

"Contributions to Stratigraphy" consists of reports dealing primarily with stratigraphy, including those defining changes in stratigraphic nomenclature in reports of the U.S. Geological Survey. The series will make available, for general information, data regarding such changes, some of which are described in this chapter, and will list other publications in which the changes have been described. "Changes in Stratigraphic Nomenclature by the U.S. Geological Survey, 1963" is the first of a series of annual reports within this series.

In recent years, as investigations of the geology of the United States have become more intensive, the volume of geologic literature has increased greatly, stratigraphic classification has become very complex, and the number of formation names has been greatly multiplied. The correlation of stratigraphic units is further complicated by the redefinition of units. Such redefinitions may include geographic extension or restriction in the use of a name, reduction or expansion in the rank of a stratigraphic term, change in age designation, or abandonment and later revival of a term. In 1963 a total of 346 changes in stratigraphic nomenclature was approved by the Geologic Names Committee of the U.S. Geological Survey for use in reports prepared for publication, as compared with 98 changes 10 years ago. Records of such changes have been tabulated by the Geologic Names Committee for distribution within the Geological Survey, but through this new publication, a permanent reference file on this information will be available to all.

The "Lexicon of Geologic Names" compiled by Wilmarth (1938) contains descriptions of more than 9,000 stratigraphic units in the United States. Many of the names of these units were established before 1900. The new lexicon compiled by Grace M. Keroher and others, soon to be published, includes 14,625 names.

THE GEOLOGIC NAMES COMMITTEE

With the beginning of regular publication of changes in stratigraphic nomenclature that have been approved by the Geologic Names Committee, it seems desirable to mention briefly some of the history and functions of the Committee and services rendered by it.

In an official organization such as the U.S. Geological Survey, which is charged with the examination of various aspects of geology throughout the United States, it is necessary that all publications adhere to some broad uniformity of procedure in dealing with the nomenclature of rock units. The Geologic Names Committee of the United States Geological Survey was first organized on February 17, 1899, to consider and determine whether all names of geologic formations or other divisions of rock classifications comply with the rules on nomenclature adopted for the Survey publications and to recommend action for unity of nomenclature.

FUNCTIONS

The Committee is responsible for defining and recommending policy and rules governing stratigraphic nomenclature for the entire Geological Survey, subject to guidance and approval by the Chief Geologist. The Committee, acting through its chairman and secretary, is responsible for the technical review of stratigraphic nomenclature and classification in manuscripts of all reports and maps originating in the U.S. Geological Survey, whether they are to be published by the Geological Survey or by an outside organization and whether they result in whole or in part from the official work of Geological Survey members.

Where there are departures from the official classification and nomenclature, the Committee considers whether the departures should be adopted as new official usage, approved for use in the particular manuscript without prejudice to official usage, or rejected. The basis of consideration is the "Code of Stratigraphic Nomenclature." Since 1890, a code of rules of nomenclature and classification has been followed in Geological Survey reports. These rules have been modified from time to time, and the Survey, through the Geologic Names Committee, is now operating under the code prepared in 1961 (American Commission on Stratigraphic Nomenclature, 1961).

Manuscript reports are critically reviewed by the review staff of the Committee under the supervision of the secretary of the Committee. Problems are brought to the attention of either the secretary or the chairman of the Committee. The Committee meets to discuss proposed substantial departures from the official classification and nomenclature, and its recommendations are submitted to the Chief Geologist for approval. Proposal of new names and new age assignments of units are considered departures from official usage.

AVAILABILITY OF COMMITTEE RECORDS FOR REFERENCE

The Geologic Names Committee for many years has maintained systematic records which include not only an index to the work of the Committee throughout its history but also an index to the stratigraphic literature of the United States insofar as names and classification are concerned.

Much of the information in these records that is based on stratigraphic literature published before 1936 is available to geologists in "Lexicon of Geologic Names of the United States," by Wilmarth (1938) and in the stratigraphic charts for each State released by the Geological Survey between 1925 and 1935. Information concerning stratigraphic names published after 1936 may be obtained from "Geologic Names of North America Introduced in 1936–1955," by Wilson, Sando, and Kopf (1957), and "Index to the Geologic Names of North America," by Wilson, Keroher, and Hansen (1959). A record of geologic names used for all stratigraphic units in the United States and its possessions is maintained by the lexicon unit. The file on each stratigraphic unit includes its age assignment, type locality, lithology, thickness, and history of usage. The Committee will provide information on the previous use of a geographic name as a stratigraphic name, the original and current definitions of a particular stratigraphic unit, the currently accepted age or classification and geographic distribution of any particular unit, and similar material in the Committee's records if an inquiry is sent to offices of the Geologic Names Committee in Washington, D.C., Denver, Colo., or Menlo Park, Calif.

If a correspondent, either Survey or non-Survey, expresses his intention to use a name that has not been previously applied to a stratigraphic unit, an appropriate informal record is made to reserve the name so that others who may inquire about the name can be informed of the first author's intention. The Committee does not presume to pass judgment on the validity or use of any name outside the publications of the U.S. Geological Survey, but its records are available at all times to all geologists.

HISTORICAL DEVELOPMENT OF THE STRATIGRAPHIC CODE

In 1882, the Director of the Survey published a general scheme of classification and a color scheme for geologic cartography (Powell, 1882). In 1889, a conference, attended by Survey geologists, was called by the Director, and from it came the first published rules of nomenclature and classification (Powell, 1890). In 1902, the Director invited all members of the Survey's scientific staff to submit their suggestions for amending the rules of nomenclature to a special committee under the supervision of G. K. Gilbert. After a series of meetings held in that year, the committee prepared a preliminary report, including a tentative draft of proposed rules, which was circulated for criticism. These and further meetings resulted in the first extensive code of regulations for the making of the Geologic Atlas of the United States (Walcott, 1903). The rules set forth by Powell and Walcott were made with special reference to the folios of the Geologic Atlas. While Walcott's report was still in press, he (written commun., Jan. 10, 1902) extended these rules as the basis for all Survey publications. The Geological Survey operated under them until 1933.

In 1930, the Association of American State Geologists appointed a committee to consider the subject of variation in nomenclature of identical rock units on different sides of State boundaries. The Association invited the aid of three-man committees from three other organizations—the U.S. Geological Survey, Geological Society of America, and American Association of Petroleum Geologists—to consider the general subject of stratigraphic classification and nomenclature. The 12 people in the 4 organizations were constituted as a national committee under the chairmanship of T. W. Stanton. This committee requested the U.S. Geological Survey to codify all its rules as a basis on which the committee might operate. T. W. Stanton, H. D. Miser, and G. W. Stose, as members of the national committee, asked other members of the Geologic Names Committee, U.S. Geological Survey, to help formulate existing Survey nomenclatural procedures; J. B. Reeside, W. W. Rubey, and H. D. Miser were assigned to compile and undertake the actual drafting of the code. The work started with the compilation of rules extracted from the 10th and 24th Annual Reports of the U.S. Geological Survey (Powell, 1890; Walcott, 1903) plus a number of written rules that the Geologic Names Committee had formulated since these Annual Reports had been published. The first draft went to two meetings of the general national committee and was returned to the Survey committee for the incorporation of changes and to be developed further as the national committee's code. The code, "Classification and Nomenclature of Rock Units," was published in the Bulletin of the Geological Society of America in 1933 and in the Bulletin of the American Association of Petroleum Geologists in 1939 (Ashley and others, 1933, 1939).

Steps leading to the establishment of a joint committee like the one that had organized the preparation of the 1933 stratigraphic code were taken in May 1941. At that time the president of the Association of American State Geologists invited the other organizations represented in the committee of 1930–32 to nominate geologists officially empowered to act as delegates at meetings in Boston on December 29–30, 1941. A similar invitation was extended to the Geological Survey of Canada. According to the proposal, the purpose of the meetings was to determine the desirability of establishing a new joint agency designated tentatively as the Commission of Classification and Nomenclature of Rock Units. Represented at this meeting were the American Association of State Geologists, the U.S. Geological Survey, the American Association of Petroleum Geologists, the Geological Society of America, and the Geological Survey of Canada. It was agreed that such a commission was necessary, but the war deferred action until late 1946.

On December 27, 1946, a meeting was held in Chicago to which each of the above organizations sent three commissioners, The name of the commission was changed to the American Commission on Stratigraphic Nomenclature. Articles of organization and procedure were drawn up, and a program of work was outlined. In 1955, the membership of the Commission was expanded to include three commissioners from Mexico, who represented the following organizations: Asociación Mexicana de Geólogos Petroleros; Sociedad Geólogica Mexicana; and the Instituto de Geología de la Universidad Nacional Autónoma de México.

The first large task the Commission set for itself was the preparation of a series of reports which could serve as background material for formulating a new code of stratigraphic nomenclature. The

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following reports were published by the Commission in the Bulletin of the American Association of Petroleum Geologists:

Report 1—Declaration on naming of subsurface stratigraphic units: v. 33, no. 7, p. 1280–1282, July 1949.

Report 2—Nature, usage, and nomenclature of time-stratigraphic and geologic-time units: v. 36, no. 8, p. 1627–1638, Aug. 1952.

Report 3—Nature, usage, and nomenclature of time-stratigraphic and geologic-time units as applied to the Precambrian: v. 39, no. 9, p. 1859–1861, Sept. 1955.

Report 4—Nature, usage, and nomenclature of rock-stratigraphic units: v. 40, no. 8, p. 2003–2014, Aug. 1956.

Report 5—Nature, usage, and nomenclature of biostratigraphic units: v. 41, no. 8, p. 1877–1889, Aug. 1957.

Report 6—Application of stratigraphic classification and nomenclature to the Quaternary: v. 43, no. 3, p. 663–673, Mar. 1959.

At the annual meeting of the Commission on November 6, 1957, in Atlantic City, N.J., the chairman of the Commission was given authority to set up a committee for coordinating the activities of various committees that were to prepare sections of the new code. Carle H. Dane, Ronald K. DeFord, James Gilluly, Hollis D. Hedberg, Raymond C. Moore, and John Rodgers served as members of the coordinating committee. The chairman of the coordinating committee, early in 1958, appointed the following committees to prepare material in the special areas of their assignments for transmittal to the coordinating committee:

Committee on Rock-Stratigraphic Classification and Nomenclature: George V. Cohee, Chairman; Edwin D. McKee, Louis C. Sass, and Lawrence L. Sloss.

Committee on Geologic Time and Time-Stratigraphic Classification and Nomenclature: Grover E. Murray, Chairman; W. C. Bell, Marshall Kay, Harry E. Wheeler, and John A. Wilson.

Committee on Biostratigraphic Classification and Nomenclature: L. M. Thompson, Chairman; M. N. Bramlette, Lewis M. Cline, Kenneth E. Lohman, and E. T. Tozer.

Committee on Problems of the Quaternary: G. M. Richmond, Chairman; Richard F. Flint, John G. Fyles, Charles B. Hunt, William C. Putnam, C. Bertrand Schultz, and James H. Zumberge.

Committee on Problems of the Precambrian and Igneous and Metamorphic Rocks: C. H. Stockwell, Chairman; C. A. Anderson, James E. Gill, Harold L. James, and J. E. Thomson.

These committees were asked to submit material to the coordinating committee for use in the new code, following the general format of the 1933 code. The coordinating committee met at various times to assemble drafts of the code for consideration by the entire Commission. The final draft was approved unanimously by the Commission at its annual meeting in Denver, Colo., November 2, 1960. Final editing was done by an editorial committee, and the new code was published in May 1961 (American Commission on Stratigraphic Nomenclature, 1961).

Upon completion of the new code, the Geologic Names Committee met to review and consider its adoption by the U.S. Geological Survey. On June 6, 1961, approving the Committee's recommendation, the chief geologist announced the adoption of the new code by the Survey.

LISTINGS OF NOMENCLATURE CHANGES

In the following listings, the changes in stratigraphic nomenclature are grouped together in the categories of (1) new names, (2) previously used names now adopted, (3) revised names, (4) changes in age designation, and (5) abandoned names. The stratigraphic names involved in change are listed alphabetically under each category. The age of the unit, the area in which the name is employed, the title of the report, and the publication in which the change is described are given. Many of the changes in nomenclature listed here have been described in short papers included in U.S. Geological Survey Professional Paper 475–B, C, D (U.S. Geol. Survey, 1963) and Professional Paper 501–B (U.S. Geol. Survey, 1964).

NEW NAMES ADOPTED FOR OFFICIAL USE IN U.S. GEOLOGICAL SURVEY REPORTS

[Year of publication: Asterisk (*) indicates in press]

Name	Age	Location	Report in which new name is adopted: Title and authorship	Report in which new name is adopted: Publication (U.S. Geol. Survey except as indicated)	Year of publication
Al Rose Formation (of Mazourka Group)	Early Ordovician	California	New Cambrian, Ordovician, and Silurian formations in the Independence quadrangle, Inyo County, California, by D. C. Ross.	Prof. Paper 475–B	1963
Andrew Formation	Cretaceous	Mississippi and adjoining States.	Surface and subsurface stratigraphic sequence in southeastern Mississippi, by D. H. Eargle.	Prof. Paper 475–D	1963
Bachelor Mountain Rhyolite	middle or late Tertiary	Colorado	Revised Tertiary volcanic sequence in the central San Juan Mountains, Colorado, by T. A. Steven and J. C. Ratte.	do	1963
Badger Flat Limestone (of Mazourka Group).	Middle Ordovician	California	New Cambrian, Ordovician, and Silurian formations in the Independence quadrangle, Inyo County, California, by D. C. Ross.	Prof. Paper 475–B	1963
Black Hill Member (of Quinebaug Formation) (of Putnam Group).	pre-Pennsylvanian	Connecticut	The Putnam Group of eastern Connecticut, by H. R. Dixon.	Bull. 1194–C	1964
Canyon Mountain Complex	Early and Middle Triassic	Oregon	The Canyon Mountain Complex, Oregon, and the alpine mafic magma stem, by T. P. Thayer.	Prof. Paper 475–C	1963
Chadwell Member (of Lee Formation)	Mississippian and Pennsylvanian.	Kentucky	Stratigraphy of the Lee Formation in the Cumberland Mountain outcrop belt of southeastern Kentucky, by K. J. Englund.	Prof. Paper 501–B	1964
Chiapuk Rhyolite	late(?) Mesozoic	Arizona	Mesozoic formations in the Vekol Mountains, Papago Indian Reservation, Arizona, by L. A. Heindl.	Bull. 1194–G	*1964
Chiputneticook Quartz Monzonite	Devonian	Maine	Geologic map and section of the Kellyland and Vanceboro quadrangles, Maine, by D. M. Larrabee.	Map MF–269	1963
Daggett Ridge Formation	Silurian	do	do	do	1963
Dark Ridge Member (of Lee Formation)	Pennsylvanian	Kentucky	Stratigraphy of the Lee Formation in the Cumberland Mountain outcrop belt of southeastern Kentucky, by K. J. Englund.	Prof. Paper 501–B	1964
Difficulty Shale Member (of Goose Egg Formation).	Late Permian	Wyoming	The Goose Egg Formation in the Laramie Range and adjacent parts of southeastern Wyoming, by E. K. Maughan.	do	1964

Dry Lake Member (of Thirsty Canyon Tuff).	Pliocene or younger	Nevada	Thirsty Canyon Tuff of Nye and Esmeralda Counties, Nevada, by D. C. Noble, R. E. Anderson, E. B. Ekren, and J. T. O'Connor.	Prof. Paper 475–D	1963
Farmers Creek Rhyolite	middle or late Tertiary	Colorado	Revised Tertiary volcanic sequence in the central San Juan Mountains, Colorado, by T. A. Steven and J. C. Ratte.	do	1963
Fenton Pass Formation	Pleistocene(?)	Wyoming	Fenton Pass Formation (Pleistocene ?), Bighorn Basin, Wyoming, by W. L. Rohrer and E. B. Leopold.	Prof. Paper 475–C	1963
Fitz Creek Siltstone (of Tuxedni Group)	Middle Jurassic	Alaska	Revised stratigraphic nomenclature and age of the Tuxedni Group in the Cook Inlet region, Alaska, by R. L. Detterman.	do	1963
Gilpin Peak Tuff (of Potosi Volcanic Group).	middle and late Tertiary	Colorado	Tertiary volcanic stratigraphy in the western San Juan Mountains, Colorado, by R. G. Luedke and W. S. Burbank.	do	1963
Gold Flat Member (of Thirsty Canyon Tuff).	Pliocene or younger	Nevada	Thirsty Canyon Tuff of Nye and Esmeralda Counties, Nevada, by D. C. Noble, R. E. Anderson, E. B. Ekren, and J. T. O'Connor.	Prof. Paper 475–D	1963
Hensley Member (of Lee Formation)	Pennsylvanian	Kentucky	Stratigraphy of the Lee Formation in the Cumberland Mountain outcrop belt of southeastern Kentucky, by K. J. Englund.	Prof. Paper 501–B	1964
Horseshoe Mesa Member (of Redwall Limestone).	Mississippian	Arizona	Nomenclature for lithologic subdivisions of the Mississippian Redwall Limestone, Arizona, by E. D. McKee.	Prof. Paper 475–C	1963
Kellyland Formation	Silurian(?)	Maine	Geologic map and section of the Kellyland and Vanceboro quadrangles, Maine, by D. M. Larrabee.	Map MF-269	1963
Kisimilok Formation	Early Cretaceous	Alaska	*Kisimilok Formation*, by R. N. Campbell.	This report, p. A28	
Labyrinth Canyon Member (of Thirsty Canyon Tuff).	Pliocene or younger	Nevada	Thirsty Canyon Tuff of Nye and Esmeralda Counties, Nevada, by D. C. Noble, R. E. Anderson, E. B. Ekren, and J. T. O'Connor.	Prof. Paper 475–D	1963
La Garita Quartz Latite	middle or late Tertiary	Colorado	Revised Tertiary volcanic sequence in the central San Juan Mountains, Colorado, by T. A. Steven and J. C. Ratte.	do	1963
Lead Gulch Formation	Late Cambrian	California	New Cambrian, Ordovician, and Silurian formations in the Independence quadrangle, Inyo County, California, by D. C. Ross.	do	1963
Little Stone Gap Member (of Hinton Formation).	Late Mississippian	Virginia	Little Stone Gap Member of the Hinton Formation (Mississippian) in southwest Virginia, by R. L. Miller.	Prof. Paper 501–B	1964

NEW NAMES ADOPTED FOR OFFICIAL USE IN U.S. GEOLOGICAL SURVEY REPORTS—Continued

[Year of publication: Asterisk (*) indicates in press]

Name	Age	Location	Report in which new name is adopted: Title and authorship	Report in which new name is adopted: Publication (U.S. Geol. Survey except as indicated)	Year of publication
Middlesboro Member (of Lee Formation).	Pennsylvanian	Kentucky	Stratigraphy of the Lee Formation in the Cumberland Mountain outcrop belt of southeastern Kentucky, by K. J. Englund.	Prof. Paper 501-B	1964
Monola Formation	Middle Cambrian	California	Monola Formation, by C. A. Nelson	This report, p. A29	
Mooney Falls Member (of Redwall Limestone).	Mississippian	Arizona	Nomenclature for lithologic subdivisions of the Mississippian Redwall Limestone, Arizona, by E. D. McKee.	Prof. Paper 475-C	1963
Nasorak Formation (of Lisburne Group).	Early and Late Mississippian.	Alaska	Nasorak Formation, by R. H. Campbell.	This report, p. A22	
Ogotoruk Formation	Jurassic or Cretaceous	do	Ogotoruk Formation, by R. H. Campbell.	This report, p. A25	
Parleys Member (of Kelvin Formation)	Early Cretaceous	Utah	Emendation of the Kelvin Formation and Morrison Formation (?) near Salt Lake City, Utah, by M. D. Crittenden, Jr.	Prof. Paper 475-B	1963
Phonodoree Formation	late (?) Mesozoic	Arizona	Mesozoic formations in the Vekol Mountains, Papago Indian Reservation, Arizona, by L. A. Heindl.	Bull. 1194-G	*1964
Pinnacle Overlook Member (of Lee Formation).	Mississippian	Kentucky	Stratigraphy of the Lee Formation in the Cumberland Mountain outcrop belt of southeastern Kentucky, by K. J. Englund.	Prof. Paper 501-B	1964
Quinebaug Formation (of Putnam Group).	pre-Pennsylvanian	Connecticut	The Putnam Group of eastern Connecticut, by H. R. Dixon.	Bull. 1194-C	1964
Red Glacier Formation (of Tuxedni Group).	Middle Jurassic	Alaska	Revised stratigraphic nomenclature and age of the Tuxedni Group in the Cook Inlet region, Alaska, by R. L. Detterman.	Prof. Paper 475-C	1963
St. Kevin Granite	Precambrian	Colorado	St. Kevin Granite, Sawatch Range, Colorado, by Ogden Tweto and R. C. Pearson.	Prof. Paper 475-D	1963
Shallow Creek Quartz Latite	middle or late Tertiary	do	Revised Tertiarty volcanic sequence in the central San Juan Mountains, Colorado, by T. A. Steven and J. C. Ratte.	do	1963
Showshoe Mountain Quartz Latite	do	do	do	do	1963

Sunday Canyon Formation	Silurian	California	New Cambrian, Ordovician, and Silurian formations in the Independence quadrangle, Inyo County, California, by D. C. Ross.	Prof. Paper 475–B.	1963
Tamarack Canyon Dolomite	Late Cambrian	do	do	do	1963
Tatnic Hill Formation (of Putnam Group).	pre-Pennsylvanian	Connecticut	The Putnam Group of eastern Connecticut, by H.R. Dixon.	Bull. 1194–C	1964
Tatum Limestone Member (of Catahoula Sandstone).	Miocene(?) and Oligocene(?)	Mississippi, Louisiana, Alabama, and Florida.	Surface and subsurface stratigraphic sequence in southeastern Mississippi, by D.H. Eargle.	Prof. Paper 475–D	1963
Telavirak Formation	Jurassic or *Cretaceous*	Alaska	*Telavirak Formation*, by R.H. Campbell.	This report, *p.* A26	
Thirsty Canyon Tuff	Pliocene or younger	Nevada	Thirsty Canyon Tuff of Nye and Esmeralda Counties, Nevada, by D.C. Noble, R.E. Anderson, E.B. Ekren, and J.T. O'Connor.	Prof. Paper 475–D	1963
Thunder Springs Member (of Redwall Limestone).	Mississippian	Arizona	Nomenclature for lithologic subdivisions of the Mississippian Redwall Limestone, Arizona, by E.D. McKee.	Prof. Paper 475–C	1963
Trail Ridge Member (of Thirsty Canyon Tuff).	Pliocene or younger	Nevada	Thirsty Canyon Tuff of Nye and Esmeralda Counties, by D.C. Noble, R.E. Anderson, E.B. Ekren, and J.T. O'Connor.	Prof. Paper 475–D	1963
Twist Creek Siltstone (of Tuxedni Group)	Middle Jurassic	Alaska	Revised stratigraphic nomemclature and age of the Tuxedni Group in the Cook Inlet region, Alaska by R.L. Detterman.	Prof. Paper 475–C	1963
Vaughn Gulch Limestone	Silurian	California	New Cambrian, Ordovician, and Silurian formations in the Independence quadrangle, Inyo County, California, by D.C. Ross.	Prof. Paper 475–B	1963
Vekol Formation	late(?) Mesozoic	Arizona	Mesozoic formations in the Vekol Mountains, Papago Indian Reservation, Arizona, by L. A. Heindl.	Bull. 1194–G	*1964
Wason Park Rhyolite	middle and late Tertiary	Colorado	Revised Tertiary volcanic sequence in the central San Juan Mountains, Colorado, by T. A. Steven and J. C. Ratte.	Prof. Paper 475–D	1963
Whitmore Wash Member (of Redwall Limestone).	Mississippian	Arizona	Nomenclature for lithologic subdivisions of the Mississippian Redwall Limestone, Arizona, by E. D. McKee.	Prof. Paper 475–C	1963
Yantic Member (of Tatnic Hill Formation) (of Putnam Group).	pre-Pennsylvanian	Connecticut	The Putnam Group of eastern Connecticut, by H. R. Dixon.	Bull. 1194–C	1964
Yucca Mountain Member (of Piapi Canyon Formation) (of Oak Spring Group).	early Pliocene or younger	Nevada	Zonal features of an ashflow sheet in the Piapi Canyon Formation, southern Nevada, by P. W. Lipman and R. L. Christiansen.	Prof. Paper 501–B	1964

PREVIOUSLY USED NAMES ADOPTED FOR OFFICIAL USE IN U.S. GEOLOGICAL SURVEY REPORTS

Name	Age	Location	Original authorship	Report in which name is adopted: Title and authorship	Report in which name is adopted: Publication (U.S. Geol. Survey except as indicated)	Year of Publication
Akron Dolomite	Late Silurian	New York	Grabau, 1909	The Helderberg Group and the position of the Silurian-Devonian boundary in North America, by J. M. Berdan.	Bull. 1180-B	1964
Apache Creek Sandstone Member (of Pierre Shale).	Late Cretaceous	Colorado	Mitchell, Greene, and Gould, 1956.	Apache Creek Sandstone Member of the Pierre Shale of southeastern Colorado, by G. R. Scott and W. A. Cobban.	Prof. Paper 475-B	1963
Chrysler Limestone	Late Silurian and Early Devonian.	New York	Chadwick, 1930	The Helderberg Group and the position of the Silurian-Devonian boundary in North America, by J. M. Berdan.	Bull. 1180-B	1964
Clark Reservation Member (of Manlius Limestone) (of Helderberg Group).	Early Devonian	do	Smith, 1929	do	do	1964
Dantzler Formation	Cretaceous	Mississippi, Alabama, and Louisiana.	Hazzard, Spooner, and Blanpied, 1947.	Surface and subsurface stratigraphic sequence in southeastern Mississippi, by D. H. Eargle.	Prof. Paper 475-D	1963
Dayville Member (of Coeymans Limestone) (of Helderberg Group).	Early Devonian	New York	Rickard, 1962	The Helderberg Group and the position of the Silurian-Devonian boundary in North America, by J. M. Berdan.	Bull. 1180-B	1964
Deansboro Member (of Coeymans Limestone) (of Helderberg Group).	do	do	do	do	do	1964
Elmwood Member (of Manlius Limestone) (of Helderberg Group).	do	do	Smith, 1929	do	do	1964
Freezeout Shale Member (of Goose Egg Formation).	Early Triassic	Wyoming	Thomas, 1934	The Goose Egg Formation in the Laramie Range and adjacent parts of southeastern Wyoming, by E. K. Maughan.	Prof. Paper 501-B	1964
Girkin Formation	Late Mississippian	Kentucky	Sutton and Weller, 1932.	Geology of the Hadley quadrangle, Kentucky, by H. C. Rainey.	Map GQ-237	1963
Glasco Member (of Rondout Limestone).	Late Silurian	New York	Chadwick, 1944	The Helderberg Group and the position of the Silurian-Devonian boundary in North America, by J. M. Berdan.	Bull. 1180-B	1964

Glendo Shale Member (of Goose Egg Formation).	Late Permian	Wyoming	Condra, Reed, and Scherer, 1940.	The Goose Egg Formation in the Laramie Range and adjacent parts of southeastern Wyoming, by E. K. Maughan.	Prof. Paper 501-B	1964
Goose Egg Formation	Early Triassic and Permian.	do	Burk and Thomas, 1956.	do	do	1964
Jamesville Member (of Manlius Limestone) (of Helderberg Group).	Early Devonian	New York	Smith, 1929	The Helderberg Group and the position of the Silurian-Devonian boundary in North America, by J. M. Berdan.	Bull. 1180-B	1964
Louann Salt	Jurassic(?)	Mississippi, Arkansas, Louisiana, and Texas.	Hazzard, Spooner, and Blanpied, 1947.	Surface and subsurface stratigraphic sequence in southeastern Mississippi, by D. H. Eargle.	Prof. Paper 475-B	1963
Mazourka Group	Early and Middle Ordovician.	California	Phleger, 1933	New Cambrian, Ordovician, and Silurian, formations in the Independence quadrangle, Inyo County, California, by D. C. Ross.	do	1963
Norphlet Formation	Jurassic	Mississippi, Arkansas, Louisiana, and Texas.	Hazzard, Spooner, and Blanpied, 1947.	Surface and subsurface stratigraphic sequence in southeastern Mississippi, by D. H. Eargle.	Prof. Paper 475-D	1963
Olney Member (of Manlius Limestone) (of Helderberg Group).	Early Devonian	New York	Smith, 1929	The Helderberg Group and the position of the Silurian-Devonian boundary in North America, by J. M. Berdan.	Bull. 1180-B	1964
Oxbow Dolomite	Late Silurian	do	Fisher, 1959	do	do	1964
Springvale Sandstone Bed (of Edgecliff Member) (of Onondaga Limestone).	Middle Devonian	do	Stauffer, 1913	The Onondaga Limestone, by W. A. Oliver, Jr.	Geol. Soc. America Guidebook Field Trip, 1963.	1963
Thatcher Member (of Manlius Limestone) (of Helderberg Group).	Early Devonian	New York, New Jersey, and Pennsylvania.	Rickard, 1962	The Helderberg Group and the position of the Silurian-Devonian boundary in North America, by J. M. Berdan.	Bull. 1180-B	1964
Tioga Bentonite Bed (of Seneca Member) (of Onondaga Limestone).	Middle Devonian	New York	Fettke, 1952	The Onondaga Limestone, by W. A. Oliver, Jr.	Geol. Soc. America Guidebook Field Trip, 1963.	1963
Union Springs Shale Member (of Marcellus Shale).	do	do	Cooper, 1930	do	do	1963
Weaverville Formation	Oligocene (?)	California	Hinds, 1933	Preliminary geologic map of the Weaverville quadrangle, California, by W. P. Irwin.	Map MF-275	1964
Werner Formation	Jurassic (?)	Mississippi, Arkansas, and Louisiana.	Hazzard, Spooner, and Blanpied, 1947.	Surface and subsurface stratigraphic sequence in southeastern Mississippi, by D. H. Eargle.	Prof. Paper 475-D	1963
Whiteport Member (of Rondout Limestone).	Early Devonian	New York, New Jersey and Pennsylvania.	Fisher, 1959	The Helderberg Group and the position of the Silurian-Devonian boundary in North America, by J. M. Berdan.	Bull. 1180-B	1964

STRATIGRAPHIC NAMES REVISED

Name	Age	Location	Revision	Report in which usage is revised: Title and authorship	Report in which usage is revised: Publication (U.S. Geol. Survey except as indicated)	Year of publication
Alboroto Rhyolite	middle or late Tertiary.	Colorado	Rocks previously included in this unit in the western San Juan Mountains are included in the Sunshine Peak Rhyolite.	Tertiary volcanic stratigraphy in the western San Juan Mountains, Colorado, by R. G. Luedke and W. S. Burbank.	Prof. Paper 475–C	1963
Bates Pond Lentil (of Tatnic Hill Formation) (of Putnam Group).	pre-Pennsylvanian.	Connecticut	Formerly Bates Pond Lentil of Putnam Gneiss.	The Putnam Group of eastern Connecticut, by H. R. Dixon.	Bull. 1194–C	1964
Big Stone Gap Member (of Chattanooga Shale).	Early Mississippian and Late Devonian.	Virginia	Big Stone Gap Shale (or Siltstone) reduced to member rank as upper member of the Chattanooga Shale for this area.	The Chattanooga Shale (Devonian and Mississippian), in the vicinity of Big Stone Gap, Virginia, by J. B. Roen, R. L. Miller, and J. W. Huddle.	Prof. Paper 501–B	1964
Borden Formation	Early Mississippian.	Kentucky	Formerly Borden Group in eastern Kentucky. Borden Group remains in good usage elsewhere.	Geology of the Shopville quadrangle, Kentucky, by N. L. Hatch.	Map GQ–282	1964
Bowser Formation (of Tuxedni Group).	Middle(?) and Late Jurassic.	Alaska	The Bowser is restricted to the upper part of the former Bowser Member of the Tuexdni Formation and redefined as the Bowser Formation of the Tuxedni Group. Formerly of Middle Jurassic age.	Revised stratigraphic nomenclature and age of the Tuxedni Group in the Cook Inlet region, Alaska, by R. L. Detterman.	Prof. Paper 475–C	1963
Brallier Shale (of Susquehanna Group).	Late Devonian	Pennsylvania	Formerly in Portage Group	Lithology, subdivision, and correlation of the Catskill Formation in east-central Pennsylvania, by D. M. Hoskins, H. H. Arndt, G. H. Wood, Jr., R. R. Conlin, J. L. Dyson, and J. P. Trexler.	Pennsylvania Geol. Survey Bull. G–39.	1963
Burns Formation (of Silverton Volcanic Group).	middle and late Tertiary.	Colorado	Formerly Burns Latite Tuff and Burns Quartz Latite of Miocene age.	Tertiary volcanic stratigraphy in the western San Juan Mountains, Colorado, by R. G. Luedke and W. S. Burbank.	Prof. Paper 475–C	1963
Campbell Mountain Member (of Bachelor Mountain Rhyolite).	do	do	Formerly Campbell Mountain Rhyolite of Miocene age.	Revised Tertiary volcanic sequence in the central San Juan Mountains, Colorado, by T. A. Steven and J. C. Ratte.	Prof. Paper 475–D	1963
Carlile Shale (of Colorado Group).	Late Cretaceous	do	Juan Lopez made a member of Carlile Shale in report area.	Geology of the Northwest and Northeast Pueblo quadrangles, Colorado, by G. R. Scott.	Map I–408	1964

Cayuga Series	Late Silurian and Early Devonian.	New York	The Manlius Limestone is assigned an Early Devonian age and is placed in the Helderberg Group rather than in the Cayuga. The Silurian-Devonian boundary is in the Rondout Limestone, which thereby becomes Late Silurian and Early Devonian in age, as does the Cayuga Series.	The Helderberg Group and the position of the Silurian-Devonian boundry in North America, by J.M. Berdan.	Bull. 1180-B	1964
Chattanooga Shale	Late Devonian and Early Mississippian.	Virginia	Big Stone Gap made a member of the Chattanooga Shale.	The Chattanooga Shale (Devonian and Mississippian) in the vicinity of Big Stone Gap, Virginia, by J.B. Roen, R.L. Miller, and J.W. Huddle.	Prof. Paper 501-B	1964
Chugwater Formation	Triassic and Permian.	Wyoming	Chugwater Formation not used for lowest strata east and northwest of Laramie, Wyoming, where the presence of carbonate rocks allow division into Little Medicine, Freezeout Shale, Ervay, and Difficulty Shale Members of the Goose Egg Formation.	The Goose Egg Formation in the Laramie Range and adjacent parts of southeastern Wyoming, by E. K. Maughan.	do	1964
Curecanti Quartz Monzonite.	Precambrian	Colorado	Formerly Curecanti Granite	Curecanti pluton, unusual intrusive body in the Black Canyon of the Gunnison, Colorado, by W. R. Hansen.	Bull. 1181-D	1964
Cynthia Falls Sandstone (of Tuxedni Group).	Middle Jurassic	Alaska	Formerly Cynthia Falls Sandstone Member of Tuxedni Formation.	Revised stratigraphic nomenclature and age of the Tuxedni Group in the Cook Inlet region, Alaska, by R. L. Detterman.	Prof. Paper 475-C	1963
Dinwoody Formation	Early Triassic	Wyoming	Little Medicine Tongue removed from Dinwoody Formation and made the uppermost member of the Goose Egg Formation.	The Goose Egg Formation in the Laramie Range and adjacent parts of southeastern Wyoming, by E. K. Maughan.	Prof. Paper 501-B	1964
Ervay Member (of Goose Egg Formation).	Late Permian	do	Formerly Ervay Tongue of Park City Formation of Permian age.	do	do	1964
Eureka Tuff (of Silverton Volcanic Group).	middle and late Tertiary.	Colorado	Changed to Eureka Tuff (instead of rhyolite). Age changed from Miocene to middle and late Tertiary.	Tertiary volcanic stratigraphy in the western San Juan Mountains, Colorado, by R. G. Luedke and W. S. Burbank.	Prof. Paper 475-C	1963
Ely Pond Member (of Tatnic Hill Formation) (of Putnam Group).	pre-Pennsylvanian.	Connecticut	Formerly Fly Pond Member of Putnam Gneiss.	The Putnam Group of eastern Connecticut, by H. R. Dixon.	Bull. 1194-C	1964
Forelle Limestone Member (of Goose Egg Formation).	Early Permian	Wyoming	Forelle Limestone changed to Forelle Limestone Member of the Goose Egg Formation in parts of southeast Wyoming. Forelle Limestone used elsewhere.	The Goose Egg Formation in the Laramie Range and adjacent parts of southeastern Wyoming, by E. K. Maughan.	Prof. Paper 501-B	1964

STRATIGRAPHIC NAMES REVISED—Continued

Name	Age	Location	Revision	Report in which usage is revised: Title and authorship	Report in which usage is revised: Publication (U.S. Geol. Survey except as indicated)	Year of publication
Gaikema Sandstone (of Tuxedni Group).	Middle Jurassic	Alaska	Formerly Gaikema Sandstone Member of Tuxedni Formation.	Revised stratigraphic nomenclature and age of the Tuxedni Group in the Cook Inlet region, Alaska, by R. L. Detterman.	Prof. Paper 475–C	1963
Glen Dean Formation	Late Mississippian (Chester).	Kentucky	Glen Dean Formation to be used in Hopkinsville-Princeton area, Kentucky. Elsewhere Glen Dean Limestone will be used.	Geology of the Kelly quadrangle, Kentucky, by T. P. Miller.	Map GQ–307	1964
Harrell Shale (of Susquehanna Group).	Late Devonian	Pennsylvania	Formerly in Portage Group	Lithology, subdivision, and correlation of the Catskill Formation in east-central Pennsylvania, by D. M. Hoskins, H. H. Arndt, G. H. Wood, Jr., R. R. Conlin, J. L. Dyson, and J. P. Trexler.	Pennsylvania Geol. Survey Bull. G–39.	1963
Helderberg Group	Early Devonian	New York	The Manlius Limestone is assigned an Early Devonian age and is included in the Helderberg Group. The Keyser Limestone is removed from the Helderberg Group.	The Helderberg Group and the position of the Silurian-Devonian boundary in North America, by J. M. Berdan.	Bull. 1180–B	1964
Henson Formation (of Silverton Volcanic Group).	middle and late Tertiary.	Colorado	Formerly Henson Tuff of Miocene age. Now includes previously unnamed pyroxene-quartz latite.	Tertiary volcanic stratigraphy in the western San Juan Mountains, Colorado, by R. G. Luedke and W. S. Burbank.	Prof. Paper 475–C	1963
Hinton Formation	Late Mississippian.	Virginia	Little Stone Gap made a member of Hinton Formation in southwest Virginia.	Little Stone Gap Member of the Hinton Formation (Mississippian) in southwest Virginia, by R. L. Miller.	Prof. Paper 501–B	1964
Huerto Formation	middle and late Tertiary.	Colorado	Huerto Formation used in report area. Elsewhere, Huerto Quartz Latite is used.	Revised Tertiary volcanic sequence in the central San Juan Mountains, Colorado, by T. A. Steven and J. C. Ratté.	Prof. Paper 475–D	1963
Juana Lopez Member (of Carlile Shale) (of Colorado Group).	Late Cretaceous	do	Juana Lopez made a member of Carlile Shale in report area.	Geology of the Northwest and Northeast Pueblo quadrangles, Colorado, by G. R. Scott.	Map I–408	1964
Kelvin Formation	Early Cretaceous	Utah	Kelvin Formation redefined to include Parleys Member at base and an unnamed member above.	Emendation of the Kelvin Formation and Morrison(?) Formation near Salt Lake City, Utah, by M. D. Crittenden, Jr.	Prof. Paper 475–B	1963

Keyser Limestone	Late Silurian and Early Devonian(?).	Maryland and West Virginia.	The Keyser Limestone is removed from the Helderberg Group	The Helderberg Group and the position of the Silurian-Devonian boundary in North America, by J. M. Berdan.	Bull. 1180-B	1964
Little Medicine Member (of Goose Egg Formation).	Early Triassic	Wyoming	Formerly Little Medicine Tongue of Dinwoody Formation of Triassic age.	The Goose Egg Formation in the Laramie Range and adjacent parts of southeastern Wyoming, by E. K. Maughan.	Prof. Paper 501-B	1964
Manlius Limestone (of Helderberg Group).	Early Devonian	New York	The Manlius Limestone is placed in the Helderberg Group and is assigned an Early Devonian age.	The Helderberg Group and the position of the Silurian-Devonian boundary in North America, by J. M. Berdan.	Bull. 1180-B	1964
McCarthy Formation	Late Triassic and Early Jurassic.	Alaska	Formerly McCarthy Shale of Late Triassic age.	Preliminary geologic map of the McCarthy C-5 quadrangle, Alaska, by E. M. MacKevett, Jr.	Map I-406	1964
Minnekahta Limestone Member (of Goose Egg Formation).	Early Permian	Wyoming	Minnekahta Limestone changed to Minnekahta Limestone Member of the Goose Egg Formation in southeastern Wyoming. Minnekahta Limestone used elsewhere.	The Goose Egg Formation in the Laramie Range and adjacent parts of southeastern Wyoming, by E. K. Maughan.	Prof. Paper 501-B	1964
Nelson Mountain Quartz Latite.	middle or late Tertiary.	Colorado	Nelson Mountain Quartz Latite redefined and age changed from Miocene to middle or late Tertiary.	Revised Tertiary volcanic sequence in the central San Juan Mountains, Colorado, by T. A. Steven and J. C. Ratte.	Prof. Paper 475-D	1963
Nussbaum Alluvium	Pleistocene(?)	do	Formerly Nussbaum Formation of Pliocene(?) age.	Nussbaum Alluvium of Pleistocene(?) age at Pueblo, Colorado, by G. R. Scott.	Prof. Paper 475-C	1963
Ohio Creek Formation	Paleocene	do	Formerly Ohio Creek Conglomerate, includes the underlying conglomeratic sandstone which Lee (1912) placed in the upper part of the Mesaverde Formation.	Redefinition and correlation of the Ohio Creek Formation (Paleocene) in west-central Colorado, by D. L. Gaskill and L. H. Godwin.	do	1963
Opeche Shale Member (of Goose Egg Formation).	Early Permian	Wyoming	Opeche Shale changed to Opeche Shale Member of the Goose Egg Formation in southeastern Wyoming. Opeche Shale used elsewhere.	The Goose Egg Formation in the Laramie Range and adjacent parts of southeastern Wyoming, by E. K. Maughan.	Prof. Paper 501-B	1964
Outlet Tunnel Member (of La Garita Quartz Latite).	middle or late Tertiary.	Colorado	Formerly Outlet Tunnel Quartz Latite of Miocene age.	Revised Tertiary volcanic sequence in the central San Juan Mountains, Colorado, by T. A. Steven and J. C. Ratte.	Prof. Paper 475-D	1963
Paint Creek Limestone	Late Mississippian (Chester).	Kentucky	Paint Creek Limestone to be used in Hopkinsville area, Kentucky. Paint Creek Shale or Paint Creek Formation good elsewhere.	Geology of the Kelly quadrangle, Kentucky, by T. P. Miller.	Map GQ-307	1964
Phoenix Park Member (of La Garita Quartz Latite).	middle or late Tertiary.	Colorado	Formerly Phoenix Park Quartz Latite of Miocene age.	Revised Tertiary volcanic sequence in the central San Juan Mountains, Colorado, by T. A. Steven and J. C. Ratte.	Prof. Paper 475-D	1963

STRATIGRAPHIC NAMES REVISED—Continued

Name	Age	Location	Revision	Report in which usage is revised: Title and authorship	Report in which usage is revised: Publication (U.S. Geol. Survey except as indicated)	Year of publication
Piapi Canyon Formation (of Oak Spring Group).	early Pliocene or younger.	Nevada	A new unit, the Yucca Mountain, made a member of the Piapi Canyon Formation.	Zonal features of an ash-flow sheet in the Piapi Canyon Formation, southern Nevada, by P. W. Lipman and R. L. Christiansen.	Prof. Paper 501-B	1964
Picayune Formation (of Silverton Volcanic Group).	middle and late Tertiary.	Colorado	Formerly Picayune Quartz Latite and Picayune Volcanic Group of Miocene age.	Tertiary volcanic stratigraphy in the western San Juan Mountains, Colorado, by R. G. Luedke and W. S. Burbank.	Prof. Paper 475-C	1963
Pierre Shale	Late Cretaceous	Colorado	Apache Creek Sandstone Member made a member of Pierre Shale.	Apache Creek Sandstone Member of the Pierre Shale of southeastern Colorado, by G. R. Scott and W. A. Cobban.	Prof. Paper 475-B	1963
Portage Group	Late Devonian	Pennsylvania	Harrell Shale and Brallier Shale removed from Portage Group and put in Susquehanna Group.	Lithology, subdivision, and correlation of the Catskill Formation in east-central Pennsylvania, by D. M. Hoskins, H. H. Arndt, G. H. Wood, Jr., R. R. Conlin, J. L. Dyson and J. P. Trexler.	Pennsylvania Geol. Survey Bull. G-39.	1963
Potosi Volcanic Group	middle and late Tertiary.	Colorado	Formerly Potosi Volcanic Series. Revised to include the Sunshine Peak Rhyolite and Gilpin Peak Tuff in the western San Juan region.	Tertiary volcanic stratigraphy in the western San Juan Mountains, Colorado, by R. G. Luedke and W. S. Burbank.	Prof. Paper 475-C	1963
Putnam Group	pre-Pennsylvanian.	Connecticut	Formerly Putnam Gneiss	The Putnam Group of eastern Connecticut, by H. R. Dixon.	Bull. 1194-C	1964
Rat Creek Quartz Latite	middle or late Tertiary.	Colorado	Rat Creek Quartz Latite redefined and restricted to northern part of Creede district, Colorado.	Revised Tertiary volcanic sequence in the central San Juan Mountains, Colorado, by T.A. Steven and J.C. Ratte.	Prof. Paper 475-D	1963
Redwall Limestone	Mississippian	Arizona	Redwall Limestone divided into four members in ascending order: Whitmore Wash, Thunder Springs, Mooney Falls, and Horseshoe Mesa Members.	Nomenclature for lithologic subdivision of the Mississippian Redwall Limestone, Arizona, by E.D. McKee.	Prof. Paper 475-C	1963
Renault Limestone	Late Mississippian (Chester).	Kentucky	Renault Limestone to be used in Hopkinsville area, Renault Formation will be used elsewhere.	Geology of the Kelly quadrangle, Kentucky, by T.P. Miller.	Map GQ-307	1964

Revett Formation (of Ravalli Group) (of Belt Series).	Precambrian	Idaho and Montana.	Formerly Revett Quartzite	Correlations and problems in Belt Series stratigraphy, northern Idaho and western Montana, by J.E. Harrison and A.B. Campbell.	Geol. Soc. America Bull vol. 74, no. 12, p. 1413–1428.	1963
Rondout Limestone (of Cayuga Series).	Late Silurian and Devonian.	New York, New Jersey, and Pennsylvania.	Former age Late Silurian. Includes Glasco, Whiteport, and Wilbur Members. The Silurian-Devonian boundary is placed within the Rondout Limestone.	The Helderberg Group and the position of the Silurian-Devonian boundary in North America, by J. M. Berdan.	Bull. 1180–B	1964
Rosendale Member (of Rondout Limestone) (of Cayuga Series).	Late Silurian	New York	Formerly Rosendale Member of Salina Formation.	do	do	1964
San Juan Formation	middle and late Tertiary	Colorado	Formerly San Juan Tuff of Miocene(?) age.	Tertiary volcanic stratigraphy in the western San Juan Mountains, Colorado, by R. G. Luedke and W. S. Burbank.	Prof. Paper 475–C	1963
Satanka Shale	Permian	Wyoming	Satanka Shale not used east and northwest of Laramie, Wyoming. Where the Minnekahta Limestone Member is recognizable, the upper part of the Satanka is divided into the Glendo Shale, Minnekahta Limestone, and Opeche Shale Members of the Goose Egg Formation in this area only.	The Goose Egg Formation in the Laramie Range and adjacent parts of southeastern Wyoming, by E. K. Maughan.	Prof. Paper 501–B	1964
Silverton Volcanic Group	middle and late Tertiary.	Colorado	Formerly Silverton Volcanic Series of Miocene age.	Tertiary volcanic stratigraphy in the western San Juan Mountains, Colorado, by R. G. Luedke and W. S. Burbank.	Prof. Paper 475–C	1963
Spearhead Member (of Thirsty Canyon Tuff).	Pliocene or younger.	Nevada	Formerly Spearhead Rhyolite of Pliocene(?) age.	Thirsty Canyon Tuff of Nye and and Esmeralda Counties, Nevaba, by D. C. Noble, R. E. Anderson, E. B. Ekran, and J. T. O'Connor.	Prof. Paper 475–D	1963
Sunshine Peak Rhyolite (of Potosi Volcanic Group).	middle and late Tertiary.	Colorado	Assigned to the Potosi Volcanic Group. Age changed from Miocene to middle and late Tertiary.	Tertiary volcanic stratigraphy in the western San Juan Mountains, Colorado, by R. G. Luedke and W. S. Burbank.	Prof. Paper 475–C	1963
Susquehanna Group	Late Devonian	Pennsylvania	Harrell Shale and Brallier Shale removed from Portage Group and put in Susquehanna Group.	Lithology, subdivision, and correlation of the Catskill Formation in east-central Pennsylvania, by D. M. Hoskins, H. H. Arndt, G. H. Wood, Jr., R. R. Conlin, J. L. Dyson, and J. P. Trexler.	Pennsylvania Geol. Survey Bull. G–39.	1963
Treasure Mountain Rhyolite.	middle and late Tertiary.	Colorado	Replaced by the Gilpin Peak Tuff in the western San Juan Mountains.	Tertiary volcanic stratigraphy in the western San Juan Mountains, Colorado, by R. G. Luedke and W. S. Burbank.	Prof. Paper 475–C	1963

STRATIGRAPHIC NAMES REVISED—Continued

Name	Age	Location	Revision	Report in which usage is revised		Year of publication
				Title and authorship	Publication (U.S. Geol. Survey except as indicated)	
Tuxedni Group	Middle and Late Jurassic.	Alaska	Formerly Tuxedni Formation of Middle Jurassic age.	Revised stratigraphic nomenclature and age of the Tuxedni Group in the Cook Inlet region, Alaska, by R. L. Detterman.	Prof. Paper 475-C	1963
Wilbur Member (of Rondout Limestone).	Late Silurian	New York	Formerly Wilbur Limestone Member of Salina Formation.	The Helderberg Group and the position of the Silurian-Devonian boundary in North America, by J. M. Berdan.	Bull. 1180-B	1964
Willow Creek Member (of Bachelor Mountain Rhyolite).	middle or late Tertiary.	Colorado	Formerly Willow Creek Rhyolite of Miocene age.	Revised Tertiary volcanic sequence in the central San Juan Mountains, Colorado, by T. A. Steven and J. C. Ratte.	Prof. Paper 475-D	1963
Windy Gulch Member (of Bachelor Mountain Rhyolite).	do	do	Formerly Windy Gulch Rhyolite Breccia of Miocene age.	do	do	1963

CHANGES IN AGE DESIGNATION

Name	Age: New	Age: Former	Location	Report in which age designation is changed: Title and authorship	Report in which age designation is changed: Publication (U.S. Geol. Survey except as indicated)	Year of publication
Englewood Formation	Devonian and Mississippian.	Early Mississippian	North Dakota and South Dakota.	Dark shale unit of Devonian and Mississippian age in northern Wyoming and southern Montana, by C. A. Sandberg.	Prof. Paper 475–C	1963
Lee Formation	Mississippian and Pennsylvanian.	Pennsylvanian	Kentucky	Stratigraphy of the Lee Formation in the Cumberland Mountain outcrop belt of southeastern Kentucky, by K. J. England.	Prof. Paper 501–B	1964
Mammoth Mountain Rhyolite.	middle or late Tertiary	Miocene	Colorado	Revised Tertiary volcanic sequence in the central San Juan Mountains, Colorado, by T. A. Steven and J. C. Ratte.	Prof. Paper 475–D	1963
Nikolai Greenstone	Middle or Late Triassic	Permian and Triassic(?)	Alaska	Preliminary geologic map of the McCarthy C–5 quadrangle, Alaska, by E. M. MacKevett, Jr.	Map I–406	1964
Puerto Ferro Limestone	Miocene	Tertiary	Puerto Rico	Provisional geologic map of Puerto Rico and adjacent islands, by R. P. Briggs.	Map I–392	1964
Sanpoil Volcanics	Eocene or Oligocene	Eocene(?)	Washington	Geology of the Bald Knob quadrangle, Ferry and Okanogan Counties, Washington, by M. H. Staatz.	Bull. 1161–F	1963

STRATIGRAPHIC NAMES ABANDONED

Name	Age	Location	Report in which name is abandoned: Title and authorship	Report in which name is abandoned: Publication (U.S. Geol. Survey except as indicated)	Year of publication
Equity Quartz Latite	Miocene	Colorado	Revised Tertiary sequence in the central San Juan Mountains, Colorado, by T. A. Steven and J. C. Ratte.	Prof. Paper 475–D	1963
Gasper Formation or Oolite	Late Mississippian	Kentucky, Tennessee, Alabama, and Georgia.	Geology of the Hadley quadrangle, Kentucky, by H. C. Rainey.	Map GQ–237	1963
Inglis Limestone	Eocene	Florida	Problems of the geographic and stratigraphic distribution of American middle Eocene larger Foraminifera, by W. S. Cole and E. R. Applin.	Bull. Am. Paleontology, v. 47.	1964

NASORAK FORMATION

By Russell H. Campbell

Name and type section.—The Nasorak Formation of Alaska forms the lower part of the Lisburne Group. The Nasorak is a limestone sequence here named from outcrops in the sea cliffs near the mouth of Nasorak Creek (fig. 1, table 1). It includes the lower three of five informal units described in the Lisburne Group of this area (Campbell, 1960).

Table 1.—*Summary of sedimentary rocks and surficial deposits, Chariot test site and vicinity, Alaska*

System	Series	Unit Name	Thickness (feet)	Character
Tertiary(?) and Quaternary		Unconsolidated deposits	0–100	Colluvium; windblown sand and silt; fluvial terrace and flood-plain gravel, sand, and silt; marine gravel and sand; and peat.
		Unconformity		
Cretaceous	Lower(?) Cretaceous	Fortress Mountain(?) Formation	3,000+	Rhythmically interbedded silty mudstone and sandstone, with minor conglomerate. Marine turbidites.
		Unconformity(?)		
Cretaceous	Lower Cretaceous	Kisimilok Formation	5,000+	Chiefly mudstone, with rhythmically interbedded sandstone abundant in basal zone. *Buchia*. Marine; turbidites common.
Jurassic or Cretaceous		Telavirak Formation	5,000+(1,000?)	Rhythmically interbedded sandstone and mudstone, with minor conglomerate. Marine turbidites.
Jurassic or Cretaceous		Ogotoruk Formation	5,000±(1,000?)	Mudstone with interbedded siltstone and sandstone. Marine; turbidites abundant.
		Disconformity(?)		
Triassic	Lower(?), Middle and Upper Triassic	Shublik Formation	200	Limestone, shale, and chert. *Monotis* abundant in some limestone beds. Marine.
		Disconformity(?)		
Permian	Lower(?) Permian	Siksikpuk Formation	400+(50?)	Argillite, chert, and minor shale. Marine.
		Disconformity(?)		
Carboniferous systems: Mississippian	Upper Mississippian	Lisburne Group: Tupik Formation	330+(150?)	Chert, mudstone, limestone, minor argillite.
Carboniferous systems: Mississippian	Upper Mississippian	Lisburne Group: Kogruk(?) Formation	3,300+(550?)	Dolomite, limestone, and calcareous sedimentary breccia with minor chert. Marine fossils.
Carboniferous systems: Mississippian	Lower and Upper Mississippian	Lisburne Group: Nasorak Formation	2,100±(50?)	Chiefly rhythmically interbedded limestone and calcareous shale, with minor interbedded silty shale. Marine fossils; limestone turbidites(?).
Carboniferous systems: Mississippian	Lower Mississippian	Sedimentary rocks, undivided	440+(1,500?)	Mudstone, sandstone, limestone, and minor conglomerate. Marine and nonmarine. Base not exposed.

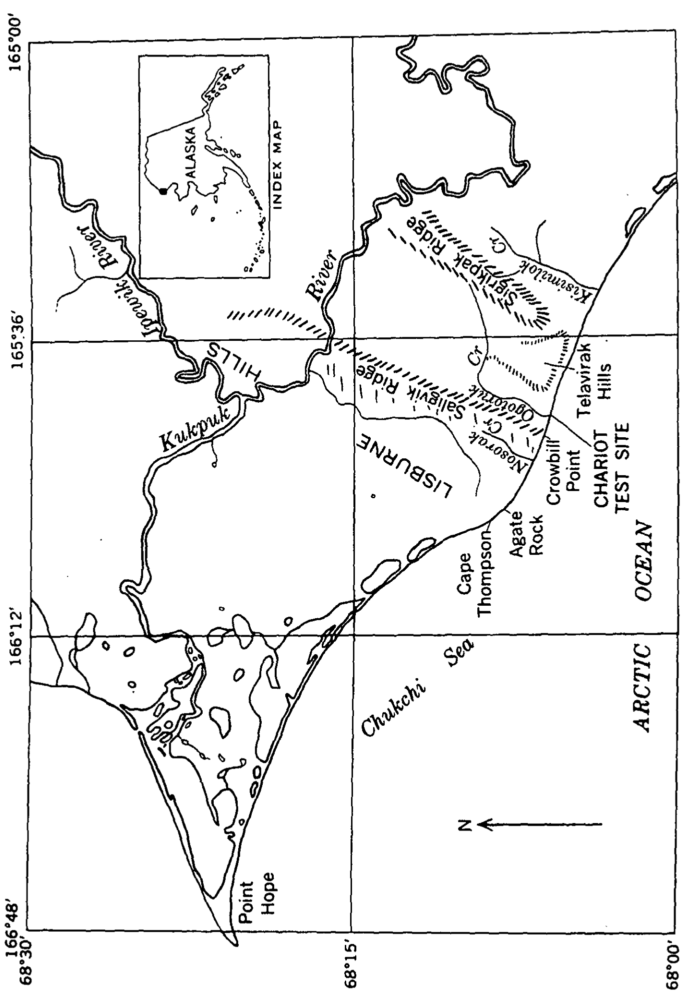

FIGURE 1.—Selected localities in the vicinity of the Chariot test site.

Lithology.—The lowermost 165 feet of the formation consists of interbedded dark-gray to grayish-black silt and clay shale, locally calcareous, and medium-gray to dark-gray cherty limestone. This zone is overlain by about 225 feet of very thick bedded light gray to light olive-gray limestone, which is in turn succeeded by about 50 feet of very thick bedded grayish-black calcareous mudstone containing small pyrite concretions and a few pyritized fossils. The uppermost 1,660 feet of the formation is remarkably uniform in lithology and bedding characteristics. It consists of rhythmically interbedded, thin-bedded to medium-bedded dark-gray limestone and very thin bedded silty calcareous shale. Shale interbeds generally decrease progressively upward both in abundance and in thickness.

The dark limestone beds of the Nasorak Formation are predominantly medium- to coarse-grained detrital organic limestone with poorly sorted clastic textures. They commonly contain from 20 to 80 percent allochems, which are almost entirely fossil fragments, in a matrix of microcrystalline calcite and silt-sized detrital calcite. Terrigenous detritus is almost entirely lacking. Nodular limestone beds containing variable amounts of dark gray to black chert are common to some horizons.

Graded bedding, poor sorting, and continuous and parallel stratification suggest that many beds of the Nasorak were deposited from turbidity currents.

The total thickness of the Nasorak Formation is about 2,100 feet.

Description of contacts.—The contact with the underlying mudstone-sandstone-limestone sequence, of Early Mississippian age, is gradational and intertonguing. The contact with the overlying Kogruk(?) Formation of the Lisburne Group is gradational. It was arbitrarily drawn at the base of the lowermost thick-bedded dolomite seen in the sea cliff section west of the mouth of Nasorak Creek.

Age and correlation.—Fossils are relatively abundant. In addition to crinoid columnals and other echinoderm detritus (abundant as allochems), the rocks include fairly well preserved bryozoa, brachiopods, horn and lithostrotionoid corals, and sparse endothryoid Foraminifera. The megafossils were examined by J. T. Dutro, Jr., and Helen M. Duncan of the Geological Survey, who conclude (written commun., 1961) that collections from the upper 1,500 feet of the Nasorak Formation indicate equivalence to the lower part of the Alapah Limestone (Late Mississippian) of the central and eastern Brooks Range and that those from the lower 500 ft. or so indicate correlation with the upper part of the Wachsmuth Limestone (Early Mississippian). They also conclude that the basal 165 feet of the Nasorak contains fossils that correlate with those of the Utukok Formation (Early Mississippian) of the western DeLong Mountains

(Sable and Dutro, 1961, p. 591–592) and that the fossils of the remaining 1,935 feet of the Nasorak are equivalent to those in part of the Kogruk Formation (Early and Late Mississippian) of the western DeLong Mountains (Sable and Dutro, 1961, p. 592). Apparently, then, the beds of the Nasorak Formation represent continuous deposition from Lower Mississippian at the base to Upper Mississippian at the top, and this formation is accordingly assigned an Early and Late Mississippian age.

OGOTORUK FORMATION

By Russell H. Campbell

Name and type locality.—The Ogotoruk Formation of Alaska is here named for exposures along Ogotoruk Creek and its tributaries, the type locality (fig. 1, table 1). It corresponds with the mudstone-sandstone unit of Campbell (1961, p. 35) and with part of the strata tentatively assigned in earlier reports (Kachadoorian and others, 1958, p. 19; Sainsbury and Campbell, 1959; and Campbell, 1960b, pls. 2 and 3) to the Tiglukpuk Formation (Patton, 1956).

Lithology.—The rocks of the Ogotoruk Formation are chiefly dark gray mudstone interbedded with variable amounts of siltstone and very fine to medium-grained dark gray and brown sandstone. The base of the formation, where exposed just east of Agate Rock, consists of several feet of dark greenish-gray claystone which is commonly highly fractured and sheared roughly parallel to the bedding. A conspicous red-weathering layer occurs about 3 feet above the base. Phosphorite nodules as much as a foot in diameter are sparsely distributed but locally common in the dark greenish-gray claystone and dark gray mudstone beds.

The dark gray mudstone, sandstone, and siltstone appear to differ only in grain size and relative abundance of clay matrix.

The rocks may be generally classified as arkosic or feldspathic wackes. The sand and coarser silt grains are predominantly angular to subangular quartz, chert, plagioclase feldspar, and mudstone fragments. The grains are poorly sorted, and the intergranular space is tightly filled with a matrix of clay and fine silt. The clays are chlorite and illite in varying proportions. Authigenic and probable authigenic minerals include sericite (?), albite, and quartz. The phosphorite nodules are chiefly aggregates of microcrystalline anhedral grains, too fine to resolve in thin section, that give an apatite X-ray diffraction pattern.

The mudstone is in massive to thin-laminated beds. In many places thin-bedded to thin-laminated mudstone is rhythmically interbedded with thin-bedded and thin-laminated siltstone and sandstone. A few thick beds of sandstone occur at irregular intervals. Mudstone beds commonly have well-defined close-spaced fracture cleavage and are locally slaty. The rhythmically interbedded units commonly show graded bedding, and the thinly laminated mudstones commonly show small-scale gentle cross-lamination. Convolute lamination is found in many of the mudstones. Where exposed, the thin individual beds appear to be relatively continuous and parallel. These bedding characteristics, together with the poor sorting, suggest that many of the strata of the Ogotoruk Formation were deposited from turbidity currents.

The thickness of the Ogotoruk Formation is not accurately known because of the complex structure, lack of exposures, and lack of marker beds or key horizons, but a total of about 5,000 feet is estimated from structure sections.

Description of contacts.—The Ogotoruk Formation is exposed in normal contact with the underlying Shublik Formation only along the sea cliff east of Agate Rock. The relations there are somewhat obscured by shearing in the basal strata of the Ogotoruk, but the contact appears to be a disconformity of very low relief. Elsewhere, the contact with older rocks is concealed by unconsolidated surficial deposits, or is faulted. The contact with the overlying Telavirak Formation is gradational.

Age and correlation.—Fossils are extremely scarce, and the few found were nondiagnostic as to age. The Ogotoruk, together with the Telavirak Formation, lies between fossil-bearing Upper Triassic and Lower Cretaceous strata. Dutro, Sable, and Bowsher (written commun., 1958) report that nondiagnostic microfossils were found in one sample near the base of the formation east of Agate Rock. They conclude, from inferred correlation with the Kingak Shale of Jurassic age (Leffingwell, 1919, p. 119–120), that the age is probably Jurassic and possibly Early Cretaceous. The Ogotoruk Formation is therefore assigned a Jurassic or Cretaceous age.

TELAVIRAK FORMATION

By Russell H. Campbell

Name and type locality.—The Telavirak Formation of Alaska is here named from the Telavirak Hills, the type locality, which lie along the coast at the southernmost end of a north-northeast-trending belt of outcrops of the formation (fig. 1, table 1). The Telavirak Formation corresponds to an unnamed informal unit of Jurassic(?) and Cretaceous age of Campbell (1960b, pl. 2), to the sandstone-mudstone unit of Campbell (1961, p. 35), and to part of the strata tentatively assigned in earlier reports (Kachadoorian and others, 1958, p. 19, and Sainsbury and Campbell, 1959) to the Tiglukpuk Formation (Patton, 1956). The topographic expression of the

Telavirak is much bolder than that of the underlying Ogotoruk Formation but is similar to the adjacent lower part of the overlying Kisimilok Formation.

Lithology.—The rocks of the Telavirak Formation are very similar to those of the Ogotoruk Formation. The Telavirak is distinguished chiefly by more nearly equal proportions of sandstone and mudstone and generally thicker bedding of the sandstone. Phosphorite nodules are prominent minor constituents in the mudstone beds at several stratigraphic horizons. Locally, a discontinuous bed of polymict coarse pebble conglomerate occurs near the base of the Telavirak.

The sandstone is commonly fine- to very fine-grained and of feldspathic or arkosic wacke composition. The clays are chiefly chlorite and illite. A few sandstone beds contain relatively abundant coarse sand- and silt-sized fragments of coalified plant debris. The pebbles of the conglomerate bed are chiefly fine-grained graywacke, mudstone, chert, and cherty limestone.

The beds of the Telavirak Formation are characteristically rhythmically interbedded mudstone and siltstone or very fine to medium-grained sandstone. The sandstone beds are generally graded and are commonly bounded at the base by sharp contacts with the underlying mudstone, whereas their contacts with the overlying mudstone are commonly gradational and intertonguing on a very fine scale. Low-angle small-scale cross-lamination is fairly common in the sandstone beds. The poor sorting, parallel stratification, graded bedding, convolute bedding in the laminated mudstones locally, and general absence of shallow-water phenomena suggests that these rocks were deposited from turbidity currents.

The thickness of the Telavirak, like that of the underlying Ogotoruk Formation, is not accurately known because of the scarcity of exposures, lack of known key horizons, and the many structural complexities. However, one partial section of at least 5,000 feet was measured along a north tributary of Ogotoruk Creek.

Description of contacts.—The contact between the Telavirak and the underlying Ogotoruk Formation is gradational. The contact was drawn at the base of the lowermost thick zone of rhythmically interbedded mudstone and thick-bedded sandstone; and because of facies changes at the base of this zone, it is probably not everywhere at precisely the same stratigraphic horizon. The contact between the Telavirak and the overlying Kisimilok Formation appears conformable in poor intermittent exposures in the eastern headwaters of Ogotoruk Creek; however, north and south of that area, structural discordance suggests that this contact lies along high-angle faults.

Age and correlation.—No diagnostic fossils have been found in the Telavirak Formation. Two collections of lebenspuren were examined by P. E. Cloud, Jr., who concluded that the fossils are long-ranged types. He (written commun., 1961) notes the association of similar forms with flysch-facies rocks in other areas and suggests that the fauna may represent deposition at bathyal or even possibly abyssal depths. As the Telavirak Formation is overlain by strata of Early Cretaceous age and, together with the Ogotoruk Formation, lies above Upper Triassic rocks, it is here assigned a Jurassic or Cretaceous age.

KISIMILOK FORMATION

By Russell H. Campbell

Name and type locality.—The Kisimilok Formation of Alaska is here named for its exposures in the vicinity of Kisimilok Creek, its type locality. It is exposed in low hills along the coast line from a point about a mile west of the mouth of Kisimilok Creek to the east edge of the map area (fig. 1, table 1). The rocks are best exposed in cutbanks of southeast- and northwest-flowing tributaries of Kisimilok Creek and along some cutbanks of the Kukpuk River. The Kisimilok Formation corresponds to the unnamed Lower Cretaceous unit of Campbell (1961, p. 36) and to strata tentatively assigned in an earlier report (Sainsbury and Campbell, 1959) to the Okpikruak Formation of Early Cretaceous age (Gryc, Patton, and Payne, 1951, p. 159-160) and to the undifferentiated Tiglukpuk(?) and Okpikruak(?) Formations.

Lithology.—Massive to thinly laminated medium-dark gray to dark gray mudstone is the dominant rock type of the Kisimilok Formation. A zone containing relatively abundant interbedded sandstone, possibly as much as 2,000 feet thick, occurs at the base of the unit. In places, it contains abundant fossils. It is overlain by 3,000 feet or more of mudstone containing only a few thick sandstone interbeds. The relative abundance of fossils, the sequence of thick zones of markedly different proportions of sandstone and mudstone, and a few subtle changes in bedding characteristics and lithology serve to distinguish this formation from the older ones beneath it.

In lithology and bedding characteristics, the rocks of this formation are very similar to those of the underlying Telavirak and Ogotoruk Formations—that is, the sandstones are graywackes of the feldspathic or arkosic type, and the mudstones have about the same composition as the matrix material of the sandstone, chlorite and illite being the predominant clays. Fossils, however, are important distinguishing constituents where present. In the sandstones, detrital calcite sand grains form a very minor but significant accessory. The mudstones, particularly in the thick zone with relatively few sandstone interbeds, are commonly less silty and more argillaceous than those of the underlying formations. Most of the sandstone is rhythmically interbedded with the mudstone in locally continuous and parallel graded beds. As in the Ogotoruk and Telavirak Formations, the bedding characteristics and textures suggest that many of the beds were deposited from turbidity currents.

The total thickness of the Kisimilok Formation could not be accurately determined because of the complex structure, absence of marker horizons, and poor exposures, but probably at least 5,000 feet of strata is represented.

Description of contacts.—The contact between the Kisimilok Formation and the underlying Telavirak Formation is apparently conformable but for much of its length is faulted. The contact between the Kisimilok Formation and the overlying Fortress Mountain(?) Formation is exposed only in rubble outcrop within the mapped area. On the basis of distinctive lithologic differences, the contact can be located fairly accurately. The general configuration of the contact and internal structures within the two formations suggest that the contact may be an eastward-dipping thrust fault, but because of poor exposures, the possibility of an unconformity cannot be ruled out.

Age and correlation.—Fossils, almost entirely pelecypods of the genus *Buchia* [-*Aucella*], are abundant locally in the lower zone of interbedded mudstone and sandstone and sparsely distributed in the overlying mudstone, but most of the beds of the Kisimilok Formation are relatively barren of fossils. David L. Jones (written commun., 1963) reports that the identifiable remains consist of *Buchia crassicolis*(?), *B.* cf. *B. sublaevis*, *B.* cf. *B. okensis*, and *B.* cf. *B. subokensis*. Lebenspuren were also found at several localities, as were worm tubes(?), and snail and indeterminable clam fragments. On the basis of the pelecypod fauna the Kisimilok Formation is assigned an Early Cretaceous age, and an age correlation with part of the Okpikruak Formation of Early Cretaceous age (Gryc, Patton, and Payne, 1951, p. 159–160) is suggested on the basis of the *Buchia* species, in conformance with the zonation of Imlay (1959, p. 165).

MONOLA FORMATION

By C. A. Nelson

Recent descriptions of stratigraphic units of the White-Inyo Mountains in California leave only one Middle Cambrian formation undescribed and unnamed within the Precambrian-Cambrian succession.

Middle Cambrian strata are widespread in the White-Inyo Mountains in the Blanco Mountain, Waucoba Mountain, Independence, Waucoba Spring, and Waucoba Wash 15-minute quadrangles (Ross, 1963, and Nelson, 1962). The upper and major part of this interval is entirely of carbonate rocks—the Bonanza King Dolomite. The basal part of the Middle Cambrian succession, here named the Monola Formation, represents a succession transitional between the principally detrital Lower Cambrian strata and the carbonate-rich younger Cambrian and Ordovician rocks.

The Monola Formation is named for exposures on the west flank of the Inyo Mountains within the Waucoba Mountain quadrangle, east and southeast of the abandoned rail station of Monola. These exposures are designated as the type area of the formation. Within the type area, the principal section is on the northwest-facing spur in the SE¼ projected sec. 6, T. 10 S., R. 35 E., about 1 mile east of Mule Spring, and a supplementary section is on the southwest-trending spur in SE¼SE¼ projected sec. 33, T. 10 S., R. 35 E. Away from the type area, the formation is almost entirely confined to the northeastern part of the Independence quadrangle (Ross, 1962), the northern and east-central parts of the Waucoba Wash quadrangle (D. C. Ross, oral commun., 1963), the eastern part of the Blanco Mountain quadrangle, and the northwestern part of the Waucoba Spring quadrangle. In the last two occurrences, the Monola is found only near Mesozoic intrusive plutons, where it is thinned and metamorphosed.

The thickness of the Monola Formation at the type area is 1,200 feet. Ross (1962) reports 1,250 feet for the equivalent beds, designated as Middle Cambrian siltstone and limestone, in the Independence quadrangle to the south. The formation appears to be of similar thickness in the Waucoba Wash quadrangle to the southeast.

In the type area, the Monola Formation is divided, on the basis of a middle limestone unit, into three members: a lower member consisting of 660 feet of limy siltstone, shaly siltstone, and thin-bedded silty limestone, all generally buff to orange brown weathering; a middle member consisting of 115 feet of well-bedded gray to blue-gray limestone with thin siltstone interbeds and forming a bold gray cliff; and an upper member, 425 feet, of dark-brown-weathering platy siltstone capped by gray and blue-gray limestone and interbedded limy shale. Owing to weathering, the formation, generally forms a colorful, diagnostic orange-brown band between the light blue-gray Mule Spring Limestone below and the dull-gray Bonanza King Dolomite above.

The lower contact of the Monola Formation with the Mule Spring Limestone is conformable. It occurs at the sharp contact separating generally massive blue-gray limestone below and swale-forming siltstone and silty limestone of the Monola Formation above. The contact with the overlying Bonanza King Dolomite is also conformable but is generally more difficult to determine. Where excellent exposures permit, it occurs at the change upward from gray and blue-gray limestone of the Monola Formation to massive gray laminated dolomite. Where exposures are poor, the contact is based on physiographic evidence as the Bonanza King forms bold cliffs that contrast with the slope-forming Monola Formation.

Type section of the Monola Formation in the Waucoba Mountain 15-minute quadrangle, Inyo County, California

[Location of principal section by California grid, zone 4. Base of section: 2,236,500; 647,400. Top of section: 2,237,500; 646,200. Location of supplementary section by same grid. Base of section: 2,248,400; 617,700. Top of section: 2,248,900; 618,700]

Bonanza King Dolomite:

Thrust contact at principal section; conformable contact at supplementary section.

	Thickness (feet)
Monola Formation (1,200 ft):	
Upper member (425 ft):	
Limestone, silty, gray to blue-gray, fine-grained, platy, locally oolitic, with rusty-brown siltstone partings. Basal parts consist of gray-buff thin-bedded limy shale. Basal beds contain *Sonoraspes nelsoni* Stoyanow	100
Limestone, sandy, gray (brown-weathering), fine-grained, thin-bedded and cross-stratified; interbedded gray limy shale. Contains *Ogygopsis klotzi* (Rominger) near top	65
Siltstone, medium-gray (dark-brown-weathering), thin-bedded to platy; interbedded brown-weathering limy gray siltstone. Contains *Ogygopsis* cf. *klotzi* (Rominger) and *Alokistocare* sp. approximately in center of unit	135
Limestone, silty, gray, fine-grained, thin-bedded (½–3 in.), alternating evenly with platy to thin-bedded brown to buff limy siltstone and brown silty shale. Unit weathers to lighter color than unit above; about 70 percent of unit is gray thin-bedded limestone	65
Shale, silty, gray, platy; interbedded buff shaly siltstone. Poorly exposed. Definite swale former	60
Middle member (115 ft):	
Limestone, gray to blue-gray, fine-grained, massive to thick-bedded (2–4 ft); irregular laminae of light-gray fine-grained limestone and thin irregular stringers of buff silt locally along bedding. Upper beds contain deformed *Girvanella*	50
Limestone, gray to blue-gray, fine-grained, thin-bedded (1–4 in.) alternating interbeds of buff limey silt (¼–1 in.) especially common at base	45
Limestone, gray to blue-gray, fine-grained, somewhat oolitic, thin-bedded (2–5 in.); buff silt interbeds in center 4 ft and basal 4 ft of unit. Generally thicker bedded than unit above or below. Forms base of major cliff-forming limestone	20
Lower member (660 ft):	
Limestone, silty to very silty, gray to buff, fine-grained, thin-bedded to platy; interbedded buff, limy siltstone (all beds ½–2 in. thick)	30
Limestone, very silty, buff-brown, fine-grained, thin-bedded (1–3 in.); alternating interbeds of platy buff to brown, shaly siltstone. Contains *Alokistocare* sp	140

	Thickness (feet)
Monola Formation (1,200 ft)—Continued	
Lower member (660 ft)—Continued	
Siltstone, limy, buff (brown-weathering), thin-bedded to platy, and buff, platy, silty shale with interbedded thin-bedded (1–3 in.) brown-gray (buff-brown-weathering) fine-grained silty limestone. Contains *Alokistocare* sp. in upper parts	380
Limestone, silty, gray to gray-buff (buff-weathering), fine-grained, medium- to thin-bedded (2 ft to 4 in.), with minor interbeds of buff limy siltstone	50
Siltstone, shaly, gray to dark-gray, very platy (chippy), and gray, silty shale. Swale former. Thickness difficult to measure accurately. Basal 10 ft contains *Syspacephalus laevigatus* Rasetti and *Oryctocephalus* sp. in Saline Valley exposures (Waucoba Wash quadrangle)	60
Conformable contact.	
Mule Spring Limestone.	

Where the Monola Formation is close to Mesozoic plutonic rocks, it is either difficult or impossible to divide into members. It retains its characteristic weathering color, but is transformed to brown siliceous hornfels, banded blue-gray crystalline limestone, and buff calc-silicate hornfels.

The Monola Formation contains a number of distinctive Middle Cambrian trilobite genera. Its basal beds contain *Syspacephalus laevigatus* and *Oryctocephalus*, suggestive of the basal Middle Cambrian *Wenkchemnia-Stephanaspis* zone. *Alokistocare* occurs virtually throughout the formation, and the upper member contains, in addition, *Ogygopsis klotzi* and *Sonoraspis* (*Glossopleura*) of the *Glossopleura* zone.

The Monola Formation (table 2) occupies the same stratigraphic position as the upper part of the Cadiz Formation of the Providence and Marble Mountains of southeastern California, but the Cadiz Formation as redefined by Hazzard (1954) contains somewhat more than 100 feet of Lower Cambrian beds at its base. In most other respects the Monola and Cadiz Formations are similar; both are underlain by algal limestone and overlain by the massive Bonanza King Formation.

The Monola is also the equivalent, in stratigraphic position and general lithologic character, to the upper part of the Carrara Formation, recently described and named by Cornwall and Kleinhampl (1961) in the Bare Mountain quadrangle, Nevada, and used by Barnes and others (1962) and by Burchfiel (1964). The Carrara Formation contains in its basal half an algal (*Girvanella*) limestone unit regarded as equivalent in part to the Mule Spring Limestone underlying the Monola Formation. Shale overlying the algal unit of the Carrara contains the highest Lower Cambrian fauna.

TABLE 2.—*Stratigraphic relations of upper Lower Cambrian and Middle Cambrian formations, California*

<table>
<tr><th colspan="2">White-Inyo Mountains (this report)</th><th colspan="2">Nevada Test Site, Bare Mtn., Nev. (Barnes and others, 1962) (Cornwall and Kleinhampl, 1961)</th><th>Providence-Marble Mountains (Hazzard, 1954)</th></tr>
<tr><td>Upper Cambrian</td><td>Bonanza King Dolomite</td><td colspan="2">Bonanza King Formation</td><td>Bonanza King Formation</td></tr>
<tr><td>Middle Cambrian</td><td>Monola Formation</td><td rowspan="2">Carrara Formation</td><td rowspan="2">Algal limestone bed</td><td>Cadiz Formation</td></tr>
<tr><td rowspan="2">Lower Cambrian</td><td>Mule Spring Limestone</td><td>Chambless Limestone</td></tr>
<tr><td></td><td colspan="2">Zabriskie Quartzite</td><td></td></tr>
</table>

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