Changes in Stratigraphic Nomenclature by the U.S. Geological Survey 1965

GEOLOGICAL SURVEY BULLETIN 1244-A

Changes in Stratigraphic Nomenclature by the U.S. Geological Survey 1965

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

CONTRIBUTIONS TO STRATIGRAPHY

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CONTENTS

ILLUSTRATIONS

TABLES

CONTRIBUTIONS TO STRATIGRAPHY

CHANGES IN STRATIGRAPHIC NOMENCLATURE BY THE U.S. GEOLOGICAL SURVEY, 1965

By George V. Cohee and Walter S. West

LISTINGS OF NOMENCLATURAL CHANGES

In the following listings, the changes in stratigraphic nomenclature are grouped together in the categories of (1) new names adopted for official use, (2) previously used names adopted for official use, (3) names revised, (4) changes in age designation, (5) names reinstated, and (6) names abandoned. 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.

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

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
Albemarle Group	early Paleozoic	North Carolina	Geology of the Carolina slate belt west of the Deep River-Wadesboro Triassic basin, North Carolina, by J. F. Conley and G. L. Bain.	Southeastern Geology, v. 6, no. 3.	1965
Aldrich Mountains Group.	Late Triassic(?) and Early Jurassic.	Oregon	Geologic map of the Canyon City quadrangle, northeastern Oregon, by C. E. Brown and T. P. Thayer.	Map I-447	1966
Ali Molina Metamorphic Complex.	Mesozoic(?)	Arizona	Mesozoic(?) rocks in the Baboquivari Mountains, Papago Indian Reservation, Arizona, by L. A. Heindl and C. L. Fair.	Bull. 1194-I	1965
Ashlock Formation	Late Ordovician (Cincinnatian).	Kentucky	Calloway Creek Limestone and Ashlock and Drakes Formations (Upper Ordovician) in south-central Kentucky, by G. W. Weir, R. C. Greene, and G. C. Simmons.	Bull. 1224-D	1965
Baboquivari Granite.	Tertiary(?)	Arizona	Mesozoic(?) rocks in the Baboquivari Mountains, Papago Indian Reservation, Arizona, by L. A. Heindl and C. L. Fair.	Bull. 1194-I	1965
Back Bed (of Tate Member of Ashlock Formation).	Late Ordovician (Cincinnatian).	Kentucky	Calloway Creek Limestone and Ashlock and Drakes Formations (Upper Ordovician) in south-central Kentucky, by G. W. Weir, R. C. Greene, and G. C. Simmons.	Bull. 1224-D	1965
Badin Greenstone (of Tater Top Group).	early Paleozoic	North Carolina	Geology of the Carolina slate belt west of the Deep River-Wadesboro Triassic basin, North Carolina, by J. F. Conley and G. L. Bain.	Southeastern Geology, v. 6, no. 3.	1965
Bell Brook Formation.	Silurian(?) or Devonian(?)	Maine	Geology of the Bridgewater quadrangle, Aroostook County, Maine, by Louis Pavlides.	Bull. 1206	1965
Boxford Formation	Silurian(?) or older	Massachusetts	Gneissic rocks in the South Groveland quadrangle, Essex County, Massachusetts, by R. O. Castle.	Prof. Paper 525-C	1965
Brady Butte Granodiorite.	Precambrian	Arizona	Unconformity between gneissic granodiorite and overlying Yavapai Series (older Precambrian), central Arizona, by P. M. Blacet.	Prof. Paper 550-B	1966
Burnt Brook Formation (of Meduxnekeag Group).	Silurian(?)	Maine	Meduxnekeag Group and Spragueville Formation of Aroostook County, northeast Maine, by Louis Pavlides.	This report, p. A52	1966
Burroughs Mountain Stade (of Winthrop Creek Glaciation).	Recent	Washington	Post-hypsithermal glacier advances at Mount Rainier, Washington, by D. R. Crandell and R. D. Miller.	Prof. Paper 501-D	1964
Calloway Creek Limestone.	Late Ordovician (Cincinnatian).	Kentucky	Calloway Creek Limestone and Ashlock and Drakes Formations (Upper Ordovician) in south-central Kentucky, by G. W. Weir, R. C. Greene, and G. C. Simmons.	Bull. 1224-D	1965

Cane Run Bed (of Grier Limestone Member of Lexington Limestone).	Middle Ordovician	do	The Lexington Limestone (Middle Ordovician) of central Kentucky, by D. F. B. Black, E. R. Cressman, and W. C. MacQuown, Jr.	Bull. 1224-C	1965
Carys Mills Formation (of Meduxnekeag Group).	Middle Ordovician to Early Silurian.	Maine	Meduxnekeag Group and Spragueville Formation of Aroostook County, northeast Maine, by Louis Pavlides.	This report, p. A55	2966
Chandler Ridge Formation (of Meduxnekeag Group).	Ordovician(?)	do	do	This report, p. A54	1966
Chiltepines Member (of Pitoikam Formation).	Mesozoic(?)	Arizona	Mesozoic(?) rocks in the Baboquivari Mountains, Papago Indian Reservation, Arizona, by L. A. Heindl and C. L. Fair.	Bull. 1194-I	1965
Clays Ferry Formation.	Middle and Late Ordovician.	Kentucky	Clays Ferry Formation (Ordovician)—a new map unit in south-central Kentucky, by G. W. Weir and R. C. Greene.	Bull. 1224-B	1965
Cocoraque Formation.	Mesozoic	Arizona	Mesozoic formations in the Comobabi and Roskruge Mountains, Papago Indian Reservation, Arizona, by L. A. Heindl.	Bull. 1194-H	1965
Contreras Conglomerate Member (of Pitoikam Formation).	Mesozoic(?)	do	Mesozoic(?) rocks in the Baboquivari Mountains, Papago Indian Reservation, Arizona, by L. A. Heindl and C. L. Fair.	Bull. 1194-I	1965
Cowbell Member (of Borden Formation).	Early Mississippian	Kentucky	Borden Formation (Mississippian) in south- and south-east-central Kentucky, by G. W. Weir, J. L. Gualtieri, and S. O. Schlanger.	Bull. 1224-F	1966
Denny Conglomerate Member (of Efland Formation).	Ordovician(?)	North Carolina	Geology of the Carolina slate belt west of the Deep River-Wadesboro Triassic basin, North Carolina, by J. F. Conley and G. L. Bain.	Southeastern Geology, v. 6, no. 3.	1965
Dobbs Buttes Member (of Roskruge Rhyolite).	Mesozoic	Arizona	Mesozoic formations in the Comobabi and Roskruge Mountains, Papago Indian Reservation, Arizona, by L. A. Heindl.	Bull. 1194-H	1965
Drakes Formation	Late Ordovician (Cincinnatian).	Kentucky	Calloway Creek Limestone and Ashlock and Drakes Formations (Upper Ordovician) in south-central Kentucky, by G. W. Weir, R. C. Greene, and G. C. Simmons.	Bull. 1224-D	1965
Dry Coyote Conglomerate Bed (of Puddle Springs Arkose Member of Wind River Formation).	Eocene	Wyoming	Puddle Springs Arkose Member of the Wind River Formation, by P. E. Soister.	This report, p. A44	1966
East Canyon Conglomerate Bed (of Puddle Springs Arkose Member of Wind River Formation).	do	do	do	This report, p. A43	1966
Efland Formation	early Paleozoic	North Carolina	Geology of the Carolina slate belt west of the Deep River-Wadesboro Triassic basin, North Carolina, by J. F. Conley and G. L. Bain.	Southeastern Geology, v. 6, no. 3.	1965

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

Name	Age	Location	Report in which new name is adopted		Year of publication
			Title and authorship	Publication (U.S. Geol. Survey except as indicated)	
Everson Interstade (of Fraser Glaciation).	Pleistocene	Washington	Late Pleistocene stratigraphy and chronology in southwestern British Columbia and northwestern Washington, by J. E. Armstrong, D. R. Crandell, D. J. Easterbrook, and J. B. Noble.	Geol. Soc. America Bull., v. 76, no. 3.	1965
Fields Creek Formation (of Aldrich Mountains Group).	Late Triassic(?)	Oregon	Geologic map of the Canyon City quadrangle, northeastern Oregon, by C. E. Brown and T. P. Thayer.	Map I-447	1966
Fish Brook Gneiss	Silurian(?) or older	Massachusetts	Gneissic rocks in the South Groveland quadrangle, Essex County, Massachusetts, by R. O. Castle.	Prof. Paper 525-C	1965
Fraser Glaciation	Pleistocene	Washington	Late Pleistocene stratigraphy and chronology in southwestern British Columbia and northwestern Washington, by J. E. Armstrong, D. R. Crandell, D. J. Easterbrook, and J. B. Noble.	Geol. Soc. America Bull., v. 76, no. 3.	1965
Garda Stade (of Winthrop Creek Glaciation).	Recent	do	Post-hypsithermal glacier advances at Mount Rainier, Washington, by D. R. Crandell and R. D. Miller.	Prof. Paper 501-D	1964
Geyser Creek Fanglomerate.	Pliocene(?)	Utah	Geyser Creek Fanglomerate (Tertiary), La Sal Mountains, eastern Utah, by W. D. Carter and J. L. Gualtieri.	Bull. 1224-E	1965
Goldman Meadows Formation.	early Precambrian	Wyoming	Geologic map of the Miners Delight quadrangle, Fremont County, Wyoming, by R. W. Bayley.	Map GQ-460	1965
Grouse Mountain Basalt.	Pliocene(?)	Colorado	Tertiary extrusive volcanic rocks in Middle Park, Grand County, Colorado, by G. A. Izett.	Prof. Paper 550-B	1966
Halfpint Member (of Nopah Formation).	Late Cambrian	Nevada	Three members of the Upper Cambrian Nopah Formation in the southern Great Basin, by R. L. Christiansen and Harley Barnes.	This report, p. A51	1966
Halls Gap Member (of Borden Formation).	Early Mississippian	Kentucky	Borden Formation (Mississippian) in south- and southeast-central Kentucky, by G. W. Weir, J. L. Gualtieri, and S. O. Schlanger.	Bull. 1224-F	1966
Katak Glaciation	Recent	Alaska	Quaternary geology of the Mount Chamberlin area, Brooks Range, Alaska, by G. W. Holmes and C. R. Lewis.	Bull. 1201-B	1965
Keller Creek Shale (of Aldrich Mountains Group).	Early Jurassic	Oregon	Geologic map of the Canyon City quadrangle, northeastern Oregon, by C. E. Brown and T. P. Thayer.	Map I-447	1966
Laycock Graywacke (of Aldrich Mountains Group).	Late Triassic(?)	do	do	do	1966
Luce Gravel	Pliocene	Indiana and Kentucky.	Geomorphology and Quaternary geology of the Owensboro quadrangle, Indiana and Kentucky, by L. L. Ray.	Prof. Paper 488	1965

Macedonia Bed (of Grier Limestone Member of Lexington Limestone).	Middle Ordovician	Kentucky	The Lexington Limestone (Middle Ordovician) of central Kentucky, by D. F. B. Black, E. R. Cressman, and W. C. MacQuown, Jr.	Bull. 1224–C	1965
McCann Hill Chert	Middle and Late Devonian.	Alaska	Ordovician, Silurian, and Devonian biostratigraphy of east-central Alaska, by Michael Churkin, Jr., and Earl Brabb.	Am. Assoc. Petroleum Geologists Bull., v. 49, no. 2.	1965
McManus Formation (of Albemarle Group).	early Paleozoic	North Carolina	Geology of the Carolina slate belt west of the Deep River-Wadesboro Triassic basin, North Carolina, by J. F. Conley and G. L. Bain.	Southeastern Geology, v. 6, no. 3.	1965
Miners Delight Formation.	early Precambrian	Wyoming	Geologic map of the Miners Delight quadrangle, Fremont County, Wyoming, by R. W. Bayley.	Map GQ–460	1965
Morrow Mountain Rhyolite (of Tater Top Group).	early Paleozoic	North Carolina	Geology of the Carolina slate belt west of the Deep River-Wadesboro Triassic basin, North Carolina, by J. F. Conley and G. L. Bain.	Southeastern Geology, v. 6, no. 3.	1965
Mulberry Wash Volcanic Formation.	Mesozoic(?)	Arizona	Mesozoic(?) rocks in the Baboquivari Mountains, Papago Indian Reservation, Arizona, by L. A. Heindl and C. L. Fair.	Bull. 1194–I	1965
Murderers Creek Graywacke (of Aldrich Mountains Group).	Late Triassic(?)	Oregon	Geologic map of the Canyon City quadrangle, northeastern Oregon, by C. E. Brown and T. P. Thayer.	Map I–447	1966
Muskrat Conglomerate Bed (of Puddle Springs Arkose Member of Wind River Formation).	Eocene	Wyoming	Puddle Springs Arkose Member of the Wind River Formation, by P. E. Soister.	This report, p. A44	1966
Nada Member (of Borden Formation).	Early Mississippian	Kentucky	Borden Formation (Mississippian) in south- and southeast-central Kentucky, by G. W. Weir, J. L. Gualtieri, and S. O. Schlanger.	Bull. 1224–F	1966
Nancy Member (of Borden Formation).	do	do	do	do	1966
Nolia Volcanic Formation.	Mesozoic	Arizona	Mesozoic formations in the Comobabi and Roskruge Mountains, Papago Indian Reservation, Arizona, by L. A. Heindl.	Bull. 1194–H	1965
Olympia Interglaciation.	Pleistocene	Washington	Late Pleistocene stratigraphy and chronology in southwestern British Columbia and northwestern Washington, by J. E. Armstrong, D. R. Crandell, D. J. Easterbrook, and J. B. Noble.	Geol. Soc. America Bull., v. 76, no. 3.	1965
Pescadero Member (of Roskruge Rhyolite).	Mesozoic	Arizona	Mesozoic formations in the Comobabi and Roskruge Mountains, Papago Indian Reservation, Arizona, by L. A. Heindl.	Bull. 1194–H	1965
Pete Gulch Member (of Rabbit Ears Volcanics).	Oligocene	Colorado	Tertiary extrusive volcanic rocks in Middle Park, Grand County, Colorado, by G. A. Izett.	Prof. Paper 550–B	1966
Pitoikam Formation.	Mesozoic(?)	Arizona	Mesozoic(?) rocks in the Baboquivari Mountains, Papago Indian Reservation, Arizona, by L. A. Heindl and C. L. Fair.	Bull. 1194–I	1965
Potter Hill Granite Gneiss.	Mississippian(?) or older	Connecticut and Rhode Island.	Bedrock geologic map of the Ashaway quadrangle, Connecticut-Rhode Island, by Tomas Feininger.	Map GQ–403	1965

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Preachersville Member (of Drakes Formation).	Late Ordovician (Cincinnatian).	Kentucky	Calloway Creek Limestone and Ashlock and Drakes Formations (Upper Ordovician) in south-central Kentucky, by G. W. Weir, R. C. Greene, and G. C. Simmons.	Bull. 1224–D	1965
Puddle Springs Arkose Member (of Wind River Formation).	Eocene	Wyoming	Puddle Springs Arkose Member of the Wind River Formation, by P. E. Soister.	This report, p. A43	1966
Rabbit Ears Volcanics.	Oligocene and Miocene(?)	Colorado	Tertiary extrusive volcanic rocks in Middle Park, Grand County, Colorado, by G. A. Izett.	Prof. Paper 550–B	1966
Rainstorm Member (of Johnnie Formation).	late Precambrian	Nevada	Geologic map of Jangle Ridge quadrangle, Nye and Lincoln Counties, Nevada, by Harley Barnes, R. L. Christiansen, and F. M. Byers, Jr.	Map GQ–363	1965
Reba Member (of Ashlock Formation).	Late Ordovician (Cincinnatian).	Kentucky	Calloway Creek Limestone and Ashlock and Drakes Formations (Upper Ordovician) in south-central Kentucky, by G. W. Weir, R. C. Greene, and G. C. Simmons.	Bull. 1224–D	1965
Renfro Member (of Borden Formation).	Early and Late Mississippian.	do	Borden Formation (Mississippian) in south- and southeast-central Kentucky, by G. W. Weir, J. L. Gualtieri, and S. O. Schlanger.	Bull. 1224–F	1966
Roadside Formation.	Mesozoic	Arizona	Mesozoic formations in the Comobabi and Roskruge Mountains, Papago Indian Reservation, Arizona, by L. A. Heindl.	Bull. 1194–H	1965
Roskruge Rhyolite	do	do	do	do	1965
Roundstone Bed (of Cowbell Member of Borden Formation).	Early Mississippian	Kentucky	Borden Formation (Mississippian) in south- and southeast-central Kentucky, by G. W. Weir, J. L. Gualtieri, and S. O. Schlanger.	Bull. 1224–F	1966
Roundtop Mountain Greenstone.	early Precambrian	Wyoming	Geologic map of the Miners Delight quadrangle, Fremont County, Wyoming, by R. W. Bayley.	Map GQ–460	1965
Rowland Member (of Drakes Formation).	Late Ordovician (Cincinnatian).	Kentucky	Calloway Creek Limestone and Ashlock and Drakes Formations (Upper Ordovician) in south-central Kentucky, by G. W. Weir, R. C. Greene, and G. C. Simmons.	Bull. 1224–D	1965
Sand Wells Formation.	Mesozoic	Arizona	Mesozoic formations in the Comobabi and Roskruge Mountains, Papago Indian Reservation, Arizona, by L. A. Heindl.	Bull. 1194–H	1965
Sharpners Pond Tonalite.	pre-Carboniferous	Massachusetts	A proposed revision of the subalkaline intrusive series of northeastern Massachusetts, by R. O. Castle.	Prof. Paper 525–C	1965
Sil Nakya Formation.	Mesozoic	Arizona	Mesozoic formations in the Comobabi and Roskruge Mountains, Papago Indian Reservation, Arizona, by L. A. Heindl.	Bull. 1194–H	1965

Smyrna Mills Formation.	Silurian	Maine	Graptolite-bearing Silurian rocks of the Houlton-Smyrna Mills area, Aroostook County, Maine, by Louis Pavlides and W. B. N. Berry.	Prof. Paper 550-B	1966
Spragueville Formation.	do	do	Meduxnekeag Group and Spragueville Formation of Aroostook County, northeast Maine, by Louis Pavlides.	This report, p. A55	1966
Stingy Creek Member (of Ashlock Formation).	Late Ordovician (Cincinnatian).	Kentucky	Calloway Creek Limestone and Ashlock and Drakes Formations (Upper Ordovician) in south-central Kentucky, by G. W. Weir, R. C. Greene, and G. C. Simmons.	Bull. 1224-D	1965
Tanglewood Limestone Member (of Lexington Limestone).	Middle Ordovician	do	The Lexington Limestone (Middle Ordovician) of central Kentucky, by D. F. B. Black, E. R. Cressman, and W. C. MacQuown, Jr.	Bull. 1224-C	1965
Tater Top Group	early Paleozoic	North Carolina	Geology of the Carolina slate belt west of the Deep River-Wadesboro Triassic basin, North Carolina, by J. F. Conley and G. L. Bain.	Southeastern Geology, v. 6, no. 3.	1965
Terrill Member (of Ashlock Formation).	Late Ordovician (Cincinnatian).	Kentucky	Calloway Creek Limestone and Ashlock and Drakes Formations (Upper Ordovician) in south-central Kentucky, by G. W. Weir, R. C. Greene, and G. C. Simmons.	Bull. 1224-D	1965
Tillery Formation (of Albemarle Group).	early Paleozoic	North Carolina	Geology of the Carolina slate belt west of the Deep River-Wadesboro Triassic basin, North Carolina, by J. F. Conley and G. L. Bain.	Southeastern Geology, v. 6, no. 3.	1965
Uwharrie Formation.	do	do	do	do	1965
Vester Formation	Late Triassic	Oregon	Geologic map of the Canyon City quadrangle, northeastern Oregon; by C. E. Brown and T. P. Thayer.	Map-I 447	1966
Winthrop Creek Glaciation.	Recent	Washington	Post-hypsithermal glacier advances at Mount Rainier, Washington, by D. R. Crandell and R. D. Miller.	Prof. Paper 501-D	1964
Yadkin Graywacke (of Albemarle Group).	early Paleozoic	North Carolina	Geology of the Carolina slate belt west of the Deep River-Wadesboro Triassic basin, North Carolina, by J. F. Conley and G. L. Bain.	Southeastern Geology, v. 6, no. 3.	1965

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Alamogordo Member (of Lake Valley Limestone).	Early Mississippian	New Mexico	Laudon and Bowsher, 1949.	Geology of the Capitol Peak NW quadrangle, Socorro County, New Mexico, by G. O. Bachman.	Map-I-441	1965
Barrel Spring Formation.	Middle Ordovician	California	Phleger, 1933	Geology of the Independence quadrangle, Inyo County, California, by D. C. Ross.	Bull. 1181-0	1965
Battery Rock Sandstone Member (of Caseyville Formation).	Early Pennsylvanian	Kentucky and Illinois	Owen, 1856	Geology of parts of the Shetlerville and Rosiclare quadrangles, Kentucky, by D. H. Amos.	Map GQ-400	1965
Clarence Member (of Onondaga Limestone).	Middle Devonian	New York	Ozol, 1964	Clarence Member of the Onondaga Limestone, by W. A. Oliver, Jr.	This report, p. A48	1966
Conway Cut Bed (of Cowbell Member of Borden Formation).	Early Mississippian	Kentucky	Stockdale, 1939	Borden Formation (Mississippian) in south- and southeast-central Kentucky, by G. W. Weir, J. L. Gualtieri, and S. O. Schlanger.	Bull. 1224-F	1966
Copper Queen Limestone Member (of Abrigo Limestone).	Late Cambrian	Arizona	Stoyanow, A. A., 1936	Paleozoic stratigraphy of the southern part of the Mule Mountains, Arizona, by P. T. Hayes and E. R. Landis.	Bull. 1201-F	1965
DeCew Member (of Lockport Dolomite).	Middle Silurian	New York	Williams, 1914	Presence of the ostracode *Drepanellina clarki* in the type Clinton (Middle Silurian) in New York State, By J. M. Berdan and D. H. Zenger.	Prof. Paper 525-C	1965
Egremont Phyllite	Middle Ordovician	Massachusetts	Hobbs, 1893	Egremont Phyllite, by E-an Zen	This report, p. A31	1966
Everett Formation	Cambrian(?), Cambrian, or Ordovician.	Massachusetts, Connecticut, New York.	do	Everett Formation, by E-an Zen	This report, p. A32	1966
Frenchville Formation.	Early Silurian	Maine	Boucot, Field, Fletcher, Forbes, Naylor, and Pavlides, 1964.	Geology of the Bridgewater quadrangle, Aroostook County, Maine, by Louis Pavlides.	Bull. 1206	1965
Gilbert Member (of Ashlock Formation).	Late Ordovician (Cincinnatian).	Kentucky	Foerste, 1912	Calloway Creek Limestone and Ashlock and Drakes Formations (Upper Ordovician) in south-central Kentucky, by G. W. Weir, R. C. Greene, and G. C. Simmons.	Bull. 1224-D	1965
Gum Sulphur Bed (of Nancy Member of Borden Formation).	Early Mississippian	do	Stockdale, 1939	Borden Formation (Mississippian) in south- and southeast-central Kentucky, by G. W. Weir, J. L. Gualtieri, and S.O. Schlanger.	Bull. 1224-F	1966

Ilion Member (of Lockport Formation of Niagara Series).	Middle Silurian	New York	Zenger, 1962	Presence of the ostracode *Drepanellina clarki* in the type Clinton (Middle Silurian) in New York State, by J. M. Berdan and D. H. Zenger.	Prof. Paper 525-C	1965
Johnson Spring Formation.	Middle Ordovician	California	Pestana, 1960	Geology of the Independence quadrangle, Inyo County, California, by D.C. Ross.	Bull. 1181-O	1965
Lusk Member (of Caseyville Formation).	Early Pennsylvanian	Illinois and Kentucky	Weller, 1940	Geology of parts of the Shetlerville and Rosiclare quadrangles, Kentucky, by D. H. Amos.	Map GQ-400	1965
Millersburg Member (of Lexington Limestone).	Middle Ordovician	Kentucky	Foerste, 1914	The Lexington Limestone (Middle Ordovician) of central Kentucky, by D. F. B. Black, E. R. Cressman, and W. C. MacQuown, Jr.	Bull. 1224-C	1965
Monteagle Limestone.	Late Mississippian	Tennessee and Kentucky.	Stearns, 1963	Geologic map of the Cumberland City quadrangle, southern Kentucky, by R. Q. Lewis, Sr., and R. E. Thaden.	Map GQ-475	1965
Nunn Member (of Lake Valley Limestone).	Early Mississippian	New Mexico	Laudon and Bowsher, 1949.	Geology of the Capitol Peak NW quadrangle, Socorro County, New Mexico, by G. O. Bachman.	Map I-441	1965
Odanah Member (of Pierre Shale).	Late Cretaceous	North Dakota	Tyrrell, 1890	Stratigraphy of the Pierre Shale, Valley City and Pembina Mountain areas, North Dakota, by J. R. Gill and W. A. Cobban.	Prof. Paper 392-A	1965
Payton Ranch Limestone Member (of Gazelle Formation).	Middle or Late Silurian.	California	Churkin and Langenheim 1960.	First occurrence of graptolites in the Klamath Mountains, California, by Michael Churkin, Jr.	Prof. Paper 525-C	1965
Pembina Member (of Pierre Shale).	Late Cretaceous	North Dakota	Kirk, 1930	Stratigraphy of the Pierre Shale, Valley City and Pembina Mountain areas, North Dakota, by J. R. Gill and W. A. Cobban.	Prof. Paper 392-A	1965
Picture Gorge Basalt (of Columbia River Group).	Middle Miocene	Oregon	Waters, 1961	Geologic map of the Canyon City quadrangle, northeastern Oregon, by C. E. Brown and T. P. Thayer.	Map I-447	1966
Plainfield Formation.	Cambrian(?)	Connecticut and Rhode Island.	Gregory, 1906	Bedrock geologic map of the Ashaway quadrangle, Connecticut-Rhode Island, by Tomas Feininger.	Map GQ-403	1965
Pounds Sandstone Member (of Caseyville Formation).	Early Pennsylvanian	Illinois and Kentucky	Weller, 1940	Geology of parts of the Shetlerville and Rosiclare quadrangles, Kentucky, by D. H. Amos.	Map GQ-400	1965
Priest Rapids Member (of Yakima Basalt of Columbia River Group).	Late Miocene or Early Pliocene.	Washington	Mackin, 1961	Stratigraphy of the upper part of the Yakima Basalt in Whitman and eastern Franklin Counties, Washington, by J. W. Bingham and K. L. Walters.	Prof. Paper 525-C	1965
Pyle Mountain Argillite.	Late Ordovician	Maine	Boucot, Field, Fletcher, Forbes, Naylor, and Pavlides, 1964.	Geology of the Bridgewater quadrangle, Aroostook County, Maine, by Louis Pavlides.	Bull. 1206	1965

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Rib Hill Sandstone	Early Permian	Nevada	Pennebaker, 1932	Geologic map and sections of the Ely 3 SW quadrangle, White Pine County, Nevada, by A. L. Brokaw and D. R. Shawe.	Map I–449	1965
Road River Formation.	Ordovician and Silurian.	Alaska	Jackson and Lenz, 1962.	Ordovician, Silurian, and Devonian biostratigraphy of east-central Alaska, by Michael Churkin, Jr., and Earl Brabb.	Am. Assoc. Petroleum Geologists Bull., v. 49, no. 2.	1965
Roza Member (of Yakima Basalt of Columbia River Group).	late Miocene	Washington	Mackin, 1961	Stratigraphy of the upper part of the Yakima Basalt in Whitman and eastern Franklin Counties, Washington, by J. W. Bingham and K. L. Walters.	Prof. Paper 525–C	1965
Sumas Stade or Drift (of Fraser Glaciation).	Pleistocene	do	Armstrong, 1957	Late Pleistocene stratigraphy and chronology in southwestern British Columbia and northwestern Washington, by J. E. Armstrong, D. R. Crandell, D. J. Easterbrook, and J. B. Noble.	Geol. Soc. America Bull., v. 76, no. 3.	1965
Tate Member (of Ashlock Formation).	Late Ordovician (Cincinnatian).	Kentucky	Foerste, 1906	Calloway Creek Limestone and Ashlock and Drakes Formations (Upper Ordovician) in south-central Kentucky, by G. W. Weir, R. C. Greene, and G. C. Simmons.	Bull. 1224–D	1965
Tierra Blanca Member (of Lake Valley Limestone).	Early Mississippian	New Mexico	Laudon and Bowsher, 1949.	Geology of the Capitol Peak NW quadrangle, Socorro County, New Mexico, by G. O. Bachman.	Map I–441	1965
Troublesome Formation.	middle Miocene	Colorado	Lovering and Goddard, 1950.	Tertiary extrusive volcanic rocks in Middle Park, Grand County, Colorado, by G. A. Izett.	Prof. Paper 550–B	1966
Zabriskie Quartzite.	Early Cambrian	California and Nevada.	Hazzard, 1937	Geologic map of the Jangle Ridge quadrangle, Nye and Lincoln Counties, Nevada, by Harley Barnes, R. L. Christiansen, and F. M. Byers, Jr.	Map GQ–363	1965

STRATIGRAPHIC NAMES REVISED

Name	Age	Location	Revision	Report in which usage is reversed: Title and authorship	Report in which usage is reversed: Publication (U.S. Geol. Survey except as indicated)	Year of publication
Ahorn Sandstone (of Belt Series).	Precambrian	Montana	Ahorn Sandstone in report area. Ahorn Quartzite in good usage elsewhere.	Geologic map of Pretty Prairie quadrangle, Lewis and Clark County, Montana, by M. R. Mudge.	Map GQ-454	1966
Beirdneau Member (of Jefferson Formation).	Late Devonian	Idaho	Beirdneau Member used in report area. Beirdneau Sandstone Member in good usage elsewhere.	Preliminary geologic map of the SW¼ of the Bancroft quadrangle, Bannock and Caribou Counties, Idaho, by S. S. Oriel.	Map MF-299	1965
Bliss Formation	Late Cambrian and Ordovician.	New Mexico	Bliss Formation used in report area. Bliss Sandstone in good usage elsewhere.	Geology of the Santa Rita quadrangle, New Mexico, by R. M. Hernon, W. R. Jones, and S. L. Moore.	Map GQ-306	1964
Bonanza King Dolomite.	Middle and Late Cambrian.	California	Bonanza King Dolomite used in report area. Bonanza King Formation in good usage elsewhere.	Geology of the Independence quadrangle, Inyo County, California, by D. C. Ross.	Bull. 1181-O	1965
Bonneville Formation (of Lake Bonneville Group).	Pleistocene	Utah	Bonneville Formation of report area includes all lake sediments between the Alpine and Draper Formations and therefore includes all but the upper part of the Provo Formation, which is not separated here. Provo Formation remains in good standing elsewhere.	New evidence on Lake Bonneville stratigraphy and history from southern Promontory Point, Utah, by R. B. Morrison.	Prof. Paper 525-C	1965
Borden Formation	Early and Late Mississippian.	Kentucky	Formation redefined to include the Nancy, Cowbell, Halls Gap, Nada, Wildie, Renfro, and Muldraugh Members in south- and southeast-central Kentucky; age formerly was Early Mississippian.	Borden Formation (Mississippian) in south- and southeast-central Kentucky, by G. W. Weir, J. L. Gualtieri, and S. O. Schlanger.	Bull. 1224-F	1966
Boyle Formation	Middle Devonian	do	Boyle Formation used in general area of this report. Where limestone predominates elsewhere, Boyle Limestone remains in good usage.	Geology of the Eli quadrangle, Kentucky, by R. E. Thaden and R. Q. Lewis, Sr.	Map GQ-393	1965
Brannon Member (of Lexington Limestone).	Middle Ordovician.	do	Formerly Brannon Limestone Member of the Cynthiana Formation.	The Lexington Limestone (Middle Ordovician) of central Kentucky, by D. F. B. Black, E. R. Cressman, and W. C. MacQuown, Jr.	Bull. 1224-C	1965
Brassfield Formation.	Early Silurian	do	Formerly Brassfield Limestone or Dolomite, which names are in good standing outside report area.	Geology of the Burtonville quadrangle, Kentucky, by R. H. Morris.	Map GQ-396	1965

STRATIGRAPHIC NAMES REVISED—Continued

Name	Age	Location	Revision	Report in which usage is reversed: Title and authorship	Report in which usage is reversed: Publication (U.S. Geol. Survey except as indicated)	Year of publication
Cadiz Formation	Early and Middle Cambrian.	California	Middle Cambrian rocks in the Inyo Mountains, previously assigned to the Cadiz Formation, are relegated to the Monola Formation. Cadiz Formation in good usage elsewhere.	Geology of the Independence quadrangle, Inyo County, California, by D. C. Ross.	Bull. 1181–0	1965
Chester Amphibolite Member (of Rowe Schist).	Cambrian(?)	Massachusetts	Chester Amphibolite restricted to its type locality and its proven continuations and reduced in rank to member of the Rowe Schist (as redefined in this paper). Formerly considered Ordovician in age.	A redefinition of the Rowe Schist in northwestern Massachusetts, by N. L. Hatch, Jr., A. H. Chidester, P. H. Osberg, and S. A. Norton.	This report, p. A34.	1966
Chilhowee Group	Cambrian and Cambrian(?).	Tennessee	Age of the Chilhowee Group remains Cambrian and Cambrian(?) but on fossil evidence the boundary between the two ages is moved downward to the base of the Murray Shale.	Geology of the western Great Smoky Mountains, Tennessee, by R. B. Neuman and W. H. Nelson.	Prof. Paper 349–D.	1965
Chinle Formation	Late Triassic	Utah and Colorado	Gartra Member included in Chinle Formation of report area.	Chinle Formation and Glen Canyon Sandstone in northeastern Utah and northwestern Colorado, by F. G. Poole and J. H. Stewart.	Prof. Paper 501–D.	1964
Columbia River Group.	middle Miocene through early Pliocene.	Oregon	Formerly Columbia River Basalt	Geologic map of the Canyon City quadrangle, northeastern Oregon, by C. E. Brown and T. P. Thayer.	Map I–447	1966
Cypress Formation	Late Mississippian (Chester).	Kentucky	Cypress Formation used in area between Hopkinsville and Bowling Green; Cypress Sandstone remains in good usage elsewhere.	Geologic map of the Sharon Grove quadrangle, Todd and Logan Counties, Kentucky, by G. E. Ulrich.	Map GQ–482	1966
Devils Hollow Member (of Lexington Limestone).	Middle Ordovician.	do	Formerly Devils Hollow Member of Cynthiana Formation.	The Lexington Limestone (Middle Ordovician) of central Kentucky, by D. F. B. Black, E. R. Cressman, and W. C. MacQuown, Jr.	Bull. 1224–C	1965
Draper Formation (of Lake Bonneville Group).	Pleistocene	Utah	Draper Formation of report area overlies the Bonneville Formation and includes the upper part of the Provo Formation, which is not separated here. Provo Formation remains in good standing elsewhere.	New evidence on Lake Bonneville stratigraphy and history from southern Promontory Point, Utah, by R. B. Morrison.	Prof. Paper 525–C.	1965

Dunderberg Shale Member (of Nopah Formation).	Late Cambrian	Nevada	Formerly Dunderberg Shale in southern Nevada. Dunderberg Shale remains in good usage outside report area.	Three members of the Upper Cambrian Nopah Formation in the southern Great Basin, by R. L. Christiansen and Harley Barnes.	This report, p. A49.	1966
Esmeralda Formation.	late Miocene and early Pliocene.	do	Restricted to exclude the Fraction Breccia from its lower part and to include only the predominantly sedimentary upper unit as mapped by Ferguson and others (1953).	Preliminary geologic map of Esmeralda County, Nevada, by J. P. Albers and J. H. Stewart.	Map MF-298	1965
Evans Creek Stade (of Fraser Glaciation).	Pleistocene	Washington	Formerly Evans Creek Glaciation	Late Pleistocene stratigraphy and chronology in southwestern British Columbia and northwestern Washington, by J. E. Armstrong, D. R. Crandell, D. J. Easterbrook, and J. B. Noble.	Geol. Soc. America Bull., v. 76, no. 3.	1965
Fraction Breccia	late Miocene	Nevada	Fraction Breccia removed from Esmeralda Formation.	Preliminary geologic map of Esmeralda County, Nevada, by J. P. Albers and J. H. Stewart.	Map MF-298	1965
Gallatin Group	Late Cambrian	Wyoming	Gallatin raised to group rank in map area to include (in ascending order) the Pilgrim Limestone, Snowy Range Formation, and Grove Creek Formation. Gallatin Limestone or Formation remains in good usage elsewhere.	Geologic map of the Deep Lake quadrangle, Park County, Wyoming, by W. G. Pierce.	Map GQ-478	1966
Garrard Siltstone (of Eden Group).	Late Ordovician	Kentucky	Garrard Siltstone in report area. Garrard Sandstone remains in good usage elsewhere.	Clays Ferry Formation (Ordovician)—a new map unit in south-central Kentucky, by G. W. Weir and R. C. Greene.	Bull. 1224-B	1965
Gartra Member (of Chinle Formation).	Late Triassic	Utah and Colorado	Formerly Gartra Grit Member of Ankareh Formation and remains as such outside report area.	Chinle Formation and Glen Canyon Sandstone in northeastern Utah and northwestern Colorado, by F. G. Poole and J. H. Stewart.	Prof. Paper 501-D	1964
Gila Formation	Pliocene and Pleistocene.	Arizona and New Mexico.	Gila Formation in area of report. Gila Conglomerate or Group in good usage elsewhere.	Geology of the Duncan and Canador Peak quadrangles, Arizona—New Mexico, by R. B. Morrison.	Map I-442	1966
Glen Canyon Sandstone.	Late Triassic and Early Jurassic.	Utah and Colorado	Glen Canyon Sandstone in report area. Glen Canyon Group remains in good usage elsewhere.	Chinle Formation and Glen Canyon Sandstone in northeastern Utah and northwestern Colorado, by F. G. Poole and J. H. Stewart.	Prof. Paper 501-D	1964
Muldraugh Member (of Borden Formation).	Early Mississippian.	Kentucky	Muldraugh Formation redefined at its type section and reduced in rank to Muldraugh Member of the Borden Formation.	Borden Formation (Mississippian) in south- and southeast-central Kentucky, by G. W. Weir, J. L. Gualtieri, and S. O. Schlanger.	Bull. 1224-F	1966
Nicholas Limestone Member (of Lexington Limestone).	Middle Ordovician.	do	Formerly a member of the Cynthiana Formation.	The Lexington Limestone (Middle Ordovician) of central Kentucky, by D. F. B. Black, E. R. Cressman, and W. C. MacQuown, Jr.	Bull. 1224-C	1965
Nopah Formation	Late Cambrian	Nevada	Nopah Formation used instead of Windfall Formation in report area. Divided into (ascending order) Dunderberg Shale, Halfpint, and Smoky Members.	Three members of the Upper Cambrian Nopah Formation in southern Great Basin, by R. L. Christiansen and Harley Barnes.	This report, p. A49.	1966

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STRATIGRAPHIC NAMES REVISED—Continued

Name	Age	Location	Revision	Report in which usage is reversed: Title and authorship	Report in which usage is reversed: Publication (U.S. Geol. Survey except as indicated)	Year of publication
Oregon Formation (of High Bridge Group).	Middle Ordovician.	Kentucky	Oregon Formation in report area. Oregon Limestone in good usage elsewhere.	Geologic map of the Valley View quadrangle, central Kentucky, by R. C. Greene.	Map GQ–470	1966
Pierre Shale	Late Cretaceous	North Dakota	Pierre Shale in report area subdivided (in ascending order) into the Pembina, Gregory, DeGrey, and Odanah Members.	Stratigraphy of the Pierre Shale, Valley City and Pembina Mountain areas, North Dakota, by J. R. Gill and W. A. Cobban.	Prof. Paper 392–A.	1965
Pike Creek Formation.	Oligocene(?) and Miocene.	Oregon	Formerly Pike Creek Volcanic Series of early Pliocene age.	Reconnaissance geologic map of the Adel quadrangle, Lake, Harney, and Malheur Counties, Oregon, by G. W. Walker and C. A. Repenning.	Map I–446	1965
Pilgrim Limestone (of Gallatin Group)	Late Cambrian	Wyoming	Pilgrim Limestone assigned to Gallatin Group in map area.	Geologic map of the Deep Lake quadrangle, Park County, Wyoming, by W. G. Pierce.	Map GQ–478	1966
Rowe Schist	Early to Late Cambrian and Early Ordovician(?).	Massachusetts	Includes all units above Hoosac Schist and below Moretown Formation where these formations are recognized; includes restricted Chester Amphibolite Member. Age formerly was Early Cambrian(?).	A redefinition of the Rowe Schist in northwestern Massachusetts, by N. L. Hatch, Jr., A. H. Chidester, P. H. Osberg, and S. A. Norton.	This report, p. A33.	1966
Ste. Genevieve Limestone Member (of Monteagle Limestone).	Late Mississippian.	Kentucky	Member of Monteagle Limestone in report area; elsewhere, remains Ste. Genevieve Limestone or Ste. Genevieve Limestone Member of Newman Limestone.	Geologic map of the Cumberland City quadrangle, southern Kentucky, by R. Q. Lewis, Sr., and R. E. Thaden.	Map GQ–475	1966
Smoky Member (of Nopah Formation).	Late Cambrian	Nevada	Reassigned from Windfall Formation to Nopah Formation.	Three members of the Upper Cambrian Nopah Formation in the southern Great Basin, by R. L. Christiansen and Harley Barnes.	This report, p. A49.	1966
Snowy Range Formation (of Gallatin Group).	do	Wyoming	Snowy Range Formation assigned to Gallatin Group in map area.	Geologic map of the Deep Lake quadrangle, Park County, Wyoming, by W. G. Pierce.	Map GQ–478	1966
Springvale Sandstone Bed (of Edgecliff Member of Onondaga Limestone).	Middle Devonian.	New York	Usage of Springvale Sandstone Bed is discontinued in New York.	Bois Blanc Formation, by W. A. Oliver, Jr.	This report, p. A47.	1966

Stockbridge Formation.	Early Cambrian to Early to Middle Ordovician.	Massachusetts, Connecticut, and New York.	Stockbridge Formation used in area of report; Stockbridge Limestone or Group, of Cambrian and Ordovician age, remain in good usage elsewhere.	The Stockbridge Formation, by E-an Zen.	This report, p. A30.	1966
Vashon Stade (of Fraser Glaciation):	Pleistocene	Washington	Now a stade of Fraser Glaciation	Late Pleistocene stratigraphy and chronology in southwestern British Columbia and northwestern Washington, by J. E. Armstrong, D. R. Crandell, D. J. Easterbrook, and J. B. Noble.	Geol. Soc. America Bull., v. 76, no. 3.	1965
Vernal Mesa Quartz Monzonite.	Precambrian	Colorado	Formerly Vernal Mesa Granite	The Black Canyon of the Gunnison, today and yesterday, by W. R. Hansen.	Bull. 1191	1965
Virginia Argillite	middle Precambrian.	Minnesota	Argillite in report area. Virginia Slate remains in good usage elsewhere.	Ground and surface water in the Mesabi and Vermilion Iron Range area, northeastern Minnesota, by R. D. Cotter, H. L. Young, L. R. Petri, and C. H. Prior.	Water-Supply Paper 1759-A.	1965
Walloomsac Formation.	Middle Ordovician.	Massachusetts, Connecticut, and New York.	Walloomsac Formation in area of report. Walloomsac Slate remains in good usage elsewhere.	Walloomsac Formation, by E-an Zen.	This report, p. A31.	1966
Wildie Member (of Borden Formation).	Early Mississippian.	Kentucky	Formerly Wildie Sandstone Member of Warsaw Formation of Late Mississippian age.	Borden Formation (Mississippian) in south- and southeast-central Kentucky, by G. W. Weir, J. L. Gualtieri, and S. O. Schlanger.	Bull. 1224-F	1966
Wind River Formation.	early Eocene	Wyoming	Wind River Formation in south-central part of Wind River Basin divided into lower variegated member, Puddle Springs Arkose Member, and upper transition zone.	Puddle Springs Arkose Member of the Wind River Formation, by P. E. Soister.	This report, p. A43.	1966

CHANGES IN AGE DESIGNATION

Name	Age: New	Age: Former	Location	Report in which age designation is changed: Title and authorship	Publication (U.S. Geol Survey except as indicated)	Year of publication
Abrams Mica Schist.	Carboniferous	Jurassic	California	Carboniferous isotopic age of the metamorphism of Salmon Hornblende Schist and Abrams Mica Schist, southern Klamath Mountains, California, by M. A. Lanphere and W. P. Irwin.	Prof. Paper 525-D	1965
Alapah Mountain Glaciation.	Recent	Pleistocene	Alaska	Quaternary geology and archeology of Alaska, by T. L. Pewe, D. M. Hopkins, and J. L. Giddings.	*in* Wright, H. E., Jr., and Frey, D. G., eds., The Quaternary of the United States; Princeton, N.J., Princeton Univ. Press.	1965
Arapien Shale	Middle and Late Jurassic.	Late Jurassic	Utah	Marine Jurassic gastropods, central and southern Utah, by N. F. Sohl.	Prof. Paper 503-D	1965
Artist Drive Formation.	Oligocene(?) to early Pliocene.	Oligocene	California	General geology of Death Valley, California, Part A, Stratigraphy and structure, by C. B. Hunt.	Prof. Paper 494-A	1966
Ayer Granite	Late Devonian or Early Mississippian.	late Paleozoic(?)	Connecticut and Massachusetts.	Implications of new radiometric ages in eastern Connecticut and Massachusetts, by R. Zartman, G. Snyder, T. Stern, R. Marvin, and R. Bucknam.	Prof. Paper 525-D	1965
Black Hill Member (of Quinebaug Formation of Putnam Group).	Middle(?) Ordovician or older.	pre-Pennsylvanian	do	do	do	1965
Bois Blanc Formation.	late Early Devonian.	Middle Devonian	Michigan and New York.	Bois Blanc Formation, by W. A. Oliver, Jr	This report, p. A46.	1966
Breathitt Formation and Group.	Early and Middle Pennsylvanian.	Middle Pennsylvanian.	Kentucky	Geology of the Krypton quadrangle, Kentucky, by R. B. Mixon.	GQ-389	1965
Brigham Quartzite.	late Precambrian and Early Cambrian.	Early(?) and Middle Cambrian.	Idaho	Preliminary geologic map of the SW¼ of the Bancroft quadrangle, Bannock and Caribou Counties, Idaho, by S. S. Oriel.	Map MF-299	1965
Brimfield Schist.	Middle(?) Ordovician or older	pre-Pennsylvanian	Connecticut and Massachusetts.	Implications of new radiometric ages in eastern Connecticut and Massachusetts, by R. Zartman, G. Snyder, T. Stern, R. Marvin, and R. Bucknam.	Prof. Paper 525-D	1965
Brougher Dacite.	Pliocene	late Miocene(?)	Nevada	Preliminary geologic map of Esmeralda County, Nevada, by J. P. Albers and J. H. Stewart.	Map MF-298	1965
Canterbury Gneiss.	Early Devonian	pre-Pennsylvanian	Connecticut and Massachusetts.	Implications of new radiometric ages in eastern Connecticut and Massachusetts, by R. Zartman,	Prof. Paper 525-D	1965

				G. Snyder, T. Stern, R. Marvin, and R. Bucknam.		
Chispa Andesite.	Oligocene or Miocene.	Tertiary	Nevada	Preliminary geologic map of Esmeralda County, Nevada, by J. P. Albers and J. H. Stewart.	Map MF-298	1965
Clover Creek Greenstone.	Permian to Late Triassic.	Permian	Oregon	Pre-Tertiary orogenic and plutonic intrusive activity in central and northeastern Oregon, by T. P. Thayer and C. E. Brown.	Geol. Soc. America Bull., v. 75, no. 12.	1964
Columbia River Group.	middle Miocene through early Pliocene.	Miocene and Pliocene(?).	Oregon, Washington, and Idaho.	Columbia River Group, by T. P. Thayer and C. E. Brown.	This report, p. A23.	1966
Death Canyon Member (of Gros Ventre Formation).	Middle Cambrian	Cambrian	Idaho	Geology of the Garns Mountain quadrangle, Bonneville, Madison, and Teton Counties, Idaho, by M. H. Staatz and H. V. Albee.	Bull. 1205	1966
Divide Andesite.	Pliocene	late Miocene(?)	Nevada	Preliminary geologic map of Esmeralda County, Nevada, by J. P. Albers and J. H. Stewart.	Map MF-298	1965
Elkhorn Ridge Argillite.	Early Permian to Late Triassic.	Early Permian	Oregon	Pre-Tertiary orogenic and plutonic intrusive activity in central and northeastern Oregon, by T. P. Thayer and C. E. Brown.	Geol. Soc. America Bull., v. 75, no. 12.	1964
Ellensburg Formation.	late Miocene and early Pliocene.	early Pliocene	Washington	The Yakima Basalt and Ellensburg Formation of south-central Washington, by J. W. Bingham and M. J. Grolier.	Bull. 1224-G	1966
Empire Formation.	Pliocene	Pliocene(?)	Oregon	Some western American Cenozoic gastropods of the genus *Nassarius*, by W. O. Addicott.	Prof. Paper 503-B	1965
Ely Pond Member (of Tatnic Hill Formation of Putnam Group).	Middle(?) Ordovician or older.	pre-Pennsylvanian	Connecticut	Implications of new radiometric ages in eastern Connecticut and Massachusetts, by R. Zartman, G. Snyder, T. Stern, R. Marvin, and R. Bucknam.	Prof Paper 525-D	1965
Furnace Creek Formation.	Pliocene	Miocene or Pliocene	California	General geology of Death Valley, California, Part A, Stratigraphy and structure, C. B. Hunt.	Prof. Paper 494-A	1966
Gazelle Formation.	Middle Silurian to Early Devonian.	Silurian and Early Devonian.	do	First occurrence of graptolites in the Klamath Mountains, California, by Michael Churkin, Jr.	Prof. Paper 525-C	1965
Grainger Formation or Shale.	Early Mississippian	Mississippian	Tennessee, North Carolina, and Virginia.	Geology of the western Great Smoky Mountains, Tennessee, by R. B. Neuman and W. H. Nelson.	Prof. Paper 349-D	1965
Gros Ventre Formation.	Middle and Late Cambrian.	Middle Cambrian	Idaho	Geology of the Garns Mountain quadrangle, Bonneville, Madison and Teton Counties, Idaho, by M. H. Staatz and H. F. Albee.	Bull. 1205	1966
Hamakua Volcanic Series.	Pliocene and early and middle Pleistocene.	Late Tertiary and Quaternary.	Hawaii	Paleomagnetism of Hawaiian lava flows, by R. R. Doell and Allan Cox.	Jour. Geophys. Research, v. 70, no. 14.	1965
Hawi Volcanic Series.	do	Pleistocene	do	do	do	1965
Hebron Formation.	Early Devonian or older.	pre-Pennsylvanian	Connecticut	Implications of new radiometric ages in eastern Connecticut and Massachusetts, by R. Zartman, G. Snyder, T. Stern, R. Marvin, and R. Bucknam.	Prof. Paper 525-D	1965
Hesse Quartzite or Sandstone (of Chilhowee Group).	Early Cambrian	Early Cambrian(?)	North Carolina and Tennessee.	Geology of the western Great Smoky Mountains, Tennessee, by R. B. Neuman and W. H. Nelson.	Prof. Paper 349-D	1965

CHANGES IN AGE DESIGNATION—Continued

Name	Age		Location	Report in which age designation is changed		Year of publication
	New	Former		Title and authorship	Publication (U.S. Geol Survey except as indicated)	
Hilina Volcanic Series.	Pliocene(?) and early and middle Pleistocene.	Pleistocene(?)	Hawaii	Paleomagnetism of Hawaiian lava flows, by R. R. Doell and Allan Cox.	Jour. Geophys. Research, v. 70, no. 14.	1965
Hulalalai Volcanic Series.	Pliocene(?) to Recent.	Pleistocene and Recent.	do	do	do	1965
Hunter Mountain Quartz Monzonite.	Jurassic or Cretaceous.	Cretaceous(?)	California	Geology of the Independence quadrangle, Inyo County, California, D. C. Ross.	Bull. 1181-0	1965
Inconsolable Granodiorite.	do	do	do	Isotopic ages of minerals from granitic rocks of the central Sierra Nevada and Inyo Mountains, California, by R. W. Kistler, P. C. Bateman, and W. W. Brannock.	Geol. Soc. America Bull., v. 76, no. 2.	1965
Johnnie Formation.	late Precambrian	Early Cambrian	California and Nevada.	General geology of Death Valley, California, Part A, Stratigraphy and structure, by C. B. Hunt.	Prof. Paper 494-A	1966
Johns Valley Shale.	Pennsylvanian	Late Mississippian and Early Pennsylvanian.	Arkansas	Water-resources reconnaissance of the Ouachita Mountains, Arkansas, by D. R. Albin.	Water-Supply Paper 1809-J.	1965
Kahuku Volcanic Series	Pliocene and early and middle Pleistocene.	Pleistocene	Hawaii	Paleomagnetism of Hawaiian lava flows, by R. R. Doell and Allan Cox.	Jour. Geophys. Research, v. 70, no. 14.	1965
Kendall Tuff	Oligocene or Miocene.	Tertiary	Nevada	Preliminary geologic map of Esmeralda County, Nevada, by J. P. Albers and J. H. Stewart.	Map MF-298	1965
Laupahoehoe Volcanic Series.	late Pleistocene and Recent.	Pleistocene and Recent(?).	Hawaii	Paleomagnetism of Hawaiian lava flows, by R. R. Doell and Allan Cox.	Jour. Geophys. Research, v. 70, no. 14.	1965
Lowland Creek Volcanics.	early Eocene	late Oligocene	Montana	Re-assignment of the Lowland Creek Volcanics to Eocene age, by H. W. Smedes and H. H. Thomas.	Jour. Geology, v. 73.	1965
Malpais Basalt	Pliocene or Pleistocene.	Pliocene(?)	Nevada	Preliminary geologic map of Esmeralda County, Nevada, by J. P. Albers and J. H. Stewart.	Map MF-298	1965
Maromas Granite Gneiss.	Permian	Mississippian(?) or older.	Connecticut	Implications of new radiometric ages in eastern Connecticut and Massachuestts, by R. Zartman, G. Snyder, T. Stern, R. Marvin, and R. Bucknam.	Prof. Paper 525-D	1965
Meade Peak Phosphatic Shale Member (of Phosphoria Formation).	Early Permian	Permian	Idaho, Montana, Wyoming, and Utah.	Permian coleoid cephalopods from the Phosphoria Formation in Idaho and Montana, by Mackenzie Gordon, Jr.	Prof. Paper 550-B	1966
Meda Rhyolite	Oligocene or Miocene.	Tertiary	Nevada	Preliminary geologic map of Esmeralda County, Nevada, by J. P. Albers and J. H. Stewart.	Map MF-298	1965

Merced Formation.	late Pliocene and early Pleistocene.	Pliocene and Pleistocene.	California	Some western American Cenozoic gastropods of the genus *Nassarius*, by W. O. Addicott.	Prof. Paper 503-B	1965
Middletown Gneiss.	Middle(?) Ordovician or older.	Paleozoic(?)	Connecticut	Implications of new radiometric ages in eastern Connecticut and Massachusetts, by R. Zartman, G. Snyder, T. Stern, R. Marvin, and R. Bucknam.	Prof. Paper 525-D	1965
Millerton Formation.	late Pleistocene	Pleistocene	California	Some western American Cenozoic gastropods of the genus *Nassarius*, by W. O. Addicott.	Prof. Paper 503-B	1965
Milltown Andesite.	Oligocene or Miocene.	Tertiary	Nevada	Preliminary geologic map of Esmeralda County, Nevada, by J. P. Albers and J. H. Stewart.	Map MF-298	1965
Monson Gneiss	Middle(?) Ordovician or older.	Mississippian(?) or older.	Connecticut and Massachusetts.	Implications of new radiometric ages in eastern Connecticut and Massachusetts, by R. Zartman, G. Snyder, T. Stern, R. Marvin, and R. Bucknam.	Prof. Paper 525-D	1965
Morena Rhyolite.	Oligocene or Miocene.	Tertiary	Nevada	Preliminary geologic map of Esmeralda County, Nevada, by J. P. Albers and J. H. Stewart.	Map MF-298	1965
Murray Shale	Early Cambrian	Early Cambrian(?)	North Carolina and Tennessee.	Geology of the western Great Smoky Mountains, Tennessee, by R. B. Neuman and W. H. Nelson.	Prof. Paper 349-D	1965
Nation River Formation.	Late Devonian	Pennsylvanian(?)	Alaska	Ordovician, Silurian, and Devonian biostratigraphy of east-central Alaska, by Michael Churkin, Jr., and Earl Brabb.	Am. Assoc. Petroleum Geologists Bull., v. 49, no. 2.	1965
Ninole Volcanic Series.	Pliocene	Pliocene(?)	Hawaii	Paleomagnetism of Hawaiian lava flows, by R. R. Doell and Allan Cox.	Jour. Geophys. Research, v. 70, no. 14.	1965
Noonday Dolomite.	Precambrian	Early Cambrian	California	General geology of Death Valley, California, Part A, Stratigraphy and structure, by C. B. Hunt.	Prof. Paper 494-A	1966
Oddie Rhyolite	Pliocene	early Pliocene(?)	Nevada	Preliminary geologic map of Esmeralda County, Nevada, by J. P. Albers and J. H. Stewart.	Map MF-298	1965
Orca Group	early Tertiary	Late Cretaceous(?)	Alaska	Stratigraphic significance of Tertiary fossils from the Orca Group in the Prince William Sound region, Alaska, by George Plafker and F. S. MacNeil.	Prof. Paper 550-B	1966
Pahala Ash	late Pleistocene	Pleistocene	Hawaii	Paleomagnetism of Hawaiian lava flows, by R. R. Doell and Allan Cox.	Jour. Geophys. Research, v. 70, no. 14.	1965
Pololu Volcanic Series.	Pliocene	Pliocene(?)	do	do	do	1965
Putnam Group	Middle(?) Ordovician or older.	pre-Pennsylvanian	Connecticut	Implications of new radiometric ages in eastern Connecticut and Massachusetts, by R. Zartman, G. Snyder, T. Stern, R. Marvin, and R. Bucknam.	Prof. Paper 525-D	1965
Quinebaug Formation (of Putnam Group).	do	do	do	do	do	1965
Retort Phosphatic Shale Member (of Phosphoria Formation).	Late Permian	Permian	Montana, Idaho, Wyoming, and Utah.	Permian coleoid cephalopods from the Phosphoria Formation in Idaho and Montana, by Mackenzie Gordon, Jr.	Prof. Paper 550-B	1966
Salado Formation.	do	do	New Mexico and Texas.	Loeweite, vanthoffite, bloedite, and leonite from southeastern New Mexico, by B. M. Madsen.	do	1966
Rabbit Spring Formation.	Pliocene or Pleistocene.	Pliocene(?)	Nevada	Preliminary geologic map of Esmeralda County, Nevada, by J. P. Albers and J. H. Stewart.	Map MF-298	1965

CHANGES IN AGE DESIGNATION—Continued

Name	Age		Location	Report in which age designation is changed		Year of publication
	New	Former		Title and authorship	Publication (U.S. Geol Survey except as indicated)	
Rest Spring Shale.	Late Mississippian and Pennsylvanian(?).	Mississippian and Pennsylvanian(?).	California	Geology of the Independence quadrangle, Inyo County, California, by D. C. Ross.	Bull. 1181-O	1965
Salmon Hornblende Schist.	Carboniferous	pre-Silurian	do	Carboniferous isotopic age of the metamorphism of the Salmon Hornblende Schist and Abrams Mica Schist, southern Klamath Mountains, California, by M. A. Lanphere and W. P. Irwin.	Prof. Paper 525-D	1965
Salyer Formation.	Miocene and Pliocene(?) in Cane Spring and Frenchman Flat quadrangles; late Miocene elsewhere.	late Miocene	Nevada	Geologic map of the Cane Spring quadrangle, Nye County, Nevada, by F. G. Poole, D. P. Elston, and W. J. Carr.	Map GQ-455	1965
Sandia Formation (of Magdalena Group).	Middle Pennsylvanian (Atoka) in the Manzano and San Andres Mountains. Age is Early Pennsylvanian elsewhere.	Early Pennsylvanian.	New Mexico	Geologic map of the Capitol Peak NW quadrangle, Socorro County, New Mexico, by G. O. Bachman.	Map I-441	1965
Sandstorm Rhyolite.	Oligocene or Miocene.	Tertiary	Nevada	Preliminary geologic map of Esmeralda County, Nevada, by J. P. Albers and J. H. Stewart.	Map MF-298	1965
Santa Barbara Formation.	Late Pliocene and early Pleistocene.	early Pleistocene	California	Some western American Cenozoic gastropods of the genus *Nassarius*, by W. O. Addicott.	Prof. Paper 503-B	1965
Santa Clara Formation.	Pliocene and Pleistocene.	do	do	On the identification of *Schizopyga californiana* Conrad, a California Pliocene gastropod, by W. O. Addicott.	California Acad. Sci. Proc., ser. 4, v. 33, no. 2.	1965
Scotland Schist	Early Devonian or older.	pre-Pennsylvanian	Connecticut	Implications of new radiometric ages in eastern Connecticut and Massachusetts, by R. Zartman, G. Snyder, T. Stern, R. Marvin, and R. Bucknam.	Prof. Paper 525-D	1965
Shublik Formation.	Early, Middle, and Late Triassic.	Early(?), Middle, and Late Triassic.	Alaska	Triassic rocks of Brooks Range [Alaska], in Geological Survey Research 1964; credited to N. J. Silberling and W. W. Patton, Jr.	Prof. Paper 501-A	1964
Siebert Tuff	late Miocene and early Pliocene.	late Miocene	Nevada	Preliminary geologic map of Esmeralda County, Nevada, by J. P. Albers and J. H. Stewart.	Map MF-298	1965
Spruce Top Greenstone.	Ordovician(?) to Devonian(?).	Silurian(?)	Maine	Geology of the Bridgewater quadrangle, Aroostook County, Maine, by Louis Pavlides.	Bull. 1206	1965
Stirling Quartzite.	Precambrian	Early Cambrian	California and Nevada.	General geology of Death Valley, California, Part A, Stratigraphy and structure, by C. B. Hunt.	Prof. Paper 494-A	1966

Strawberry Volcanics.	middle and late Miocene and early Pliocene.	middle and late Miocene.	Oregon	Geologic map of the Canyon City quadrangle, northeastern Oregon, by C. E. Brown and T. P. Thayer.	Map I-447	1966
Tatnic Hill Formation (of Putnam Group).	Middle(?) Ordovician or older.	pre-Pennsylvanian	Connecticut	Implications of new radiometric ages in eastern Connecticut and Massachusetts, by R. Zartman, G. Snyder, T. Stern, R. Marvin, and R. Bucknam.	Prof. Paper 525-D	1965
Tinemaha Granodiorite.	Jurassic or Cretaceous.	Cretaceous	California	Geology of the Independence quadrangle, Inyo County, California, by D. C. Ross.	Bull. 1181-0	1965
Twelvemile Canyon Member (of Arapien Shale).	Middle and Late Jurassic.	Late Jurassic	Utah	Marine Jurassic gastropods, central and southern Utah, by N. F. Ross.	Prof. Paper 503-D	1965
Upham Member or Dolomite Member (of Montoya Dolomite).	Middle and Late Ordovician.	Late Ordovician	New Mexico and Texas.	Geology of the Capitol Peak NW quadrangle, Socorro County, New Mexico, by G. O. Bachman.	Map I-441	1965
Valdez Group	Jurassic or Cretaceous.	Late Cretaceous(?)	Alaska	Stratigraphic significance of Tertiary fossils from the Orca Group in the Prince William Sound region, Alaska, by George Plafker and F. S. MacNeil.	Prof. Paper 550-B	1966
Vindicator Rhyolite.	Oligocene or Miocene.	Tertiary	Nevada	Preliminary geologic map of Esmeralda County, Nevada, by J. P. Albers and J. H. Stewart.	Map MF-298	1965
Wahmonie Formation.	Miocene and Pliocene(?) in Cane Spring and Frenchman Flat quadrangles; late Miocene and early Pliocene elsewhere.	Late Miocene and early Pliocene.	do	Geologic map of the Cane Spring quadrangle, Nye County, Nevada, by F. G. Poole, D. K. Elston, and W. J. Carr.	Map GQ-455	1965
Wayan Formation.	Early Cretaceous	Early(?) and Late Cretaceous.	Idaho and Wyoming.	Tectonic development of the Idaho-Wyoming thrust belt, by F. C. Armstrong and S. S. Oriel.	Am. Assoc. Petroleum Geologists Bull., v. 49, no. 11.	1965
Wildcat Valley Sandstone.	Early Devonian	Early and Middle(?) Devonian.	Virginia	Geology of the Big Stone Gap quadrangle, Virginia, by R. L. Miller.	Map GQ-424	1965
Wood Canyon Formation.	Precambrian and Early Cambrian.	Early Cambrian and Early Cambrian(?).	Nevada and California.	Geologic map of the Jangle Ridge quadrangle, Nye and Lincoln Counties, Nevada, by Harley Barnes. F. M. Byers, Jr., and R. L. Christiansen.	Map GQ-363	1965
Woodford Shale	Late Devonian and Early Mississippian.	Devonian and Mississippian.	Oklahoma	Late Devonian and Early Mississippian age of the Woodford Shale in Oklahoma, as determined from conodonts, by W. H. Hass and J. W. Huddle.	Prof. Paper 525-D	1965
Yantic Member (of Tatnic Hill Formation of Putnam Group).	Middle(?) Ordovician or older.	Pre-Pennsylvanian	Connecticut	Implications of new radiometric ages in eastern Connecticut and Massachusetts, by R. Zartman, G. Snyder, T. Stern, R. Marvin, and R. Bucknam.	do	1965

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STRATIGRAPHIC NAMES REINSTATED

Name	Age	Location	Report in which name is reinstated: Title and authorship	Report in which name is reinstated: Publication (U.S. Geol. Survey except as indicated)	Year of publication
Little Valley Limestone.	Mississippian	Virginia	Suggestions for prospecting for evaporite deposits in southwestern Virginia, by C. F. Withington.	Prof. Paper 525–B	1965

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
Aroostook Limestone.	Silurian	Maine	Meduxnekeag Group and Spragueville Formation of Aroostook County, northeast Maine, by Louis Pavlides.	This report, p. A56	1966
Brodhead Formation (of Borden Group).	Early Mississippian	Kentucky	Borden Formation (Mississippian) in south- and southeast-central Kentucky, by G. W. Weir, J. L. Gualtieri, and S. O. Schlanger.	Bull. 1224–F	1966
Cerro Till or Glaciation.	Pleistocene	Colorado	Landslide origin of the type Cerro Till, southwestern Colorado, by R. G. Dickinson.	Prof. Paper 525–C	1965
Cynthiana Formation.	Middle Ordovician	Kentucky	The Lexington Limestone (Middle Ordovician) of central Kentucky, by D. F. B. Black, E. R. Cressman, and W. C. MacQuown, Jr.	Bull. 1224–C	1965
North Boulder Group or Formation (of Belt Series).	Precambrian	Montana	Geologic map of the Maudlow quadrangle, southwestern Montana, by B. A. L. Skipp and A. D. Peterson.	Map I–452	1965
Woodburn Limestone Member (of Cynthiana Formation).	Middle Ordovician	Kentucky	The Lexington Limestone (Middle Ordovician) of central Kentucky, by D. F. B. Black, E. R. Cressman, and W. C. MacQuown, Jr.	Bull. 1224–C	1965

COLUMBIA RIVER GROUP

By T. P. Thayer and C. Ervin Brown

The name Columbia River Basalt was proposed by Waters (1961, p. 607) as a group to include "the Yakima Basalt as defined by G. O. Smith, and the older basalts of the John Day Basin, called the 'Columbia Lava' by Merriam, but herein renamed the Picture Gorge Basalt, with the section at Picture Gorge designated as the type section." (See fig. 1.) Because Waters intended the name to provide "the flexibility to add new formations * * *," some of which are not basaltic, the name Columbia River Group (Brown and Thayer, 1966a) is substituted for Columbia River Basalt. Within the Canyon City quadrangle the Mascall Formation (Merriam and others, 1925, p. 49) and stratigraphically equivalent rhyolitic to basaltic flows and pyroclastic rocks (Thayer, 1957, p. 238), here called the rhyolitic marginal facies, are also included with the group (fig. 2), which ranges in age from middle Miocene to early Pliocene. A marked angular unconformity separates the upper units of the Columbia River Group from the overlying Rattlesnake Formation of middle Pliocene and Pleistocene age. The rocks of the group were deposited on a surface of considerable relief and lie unconformably on the John

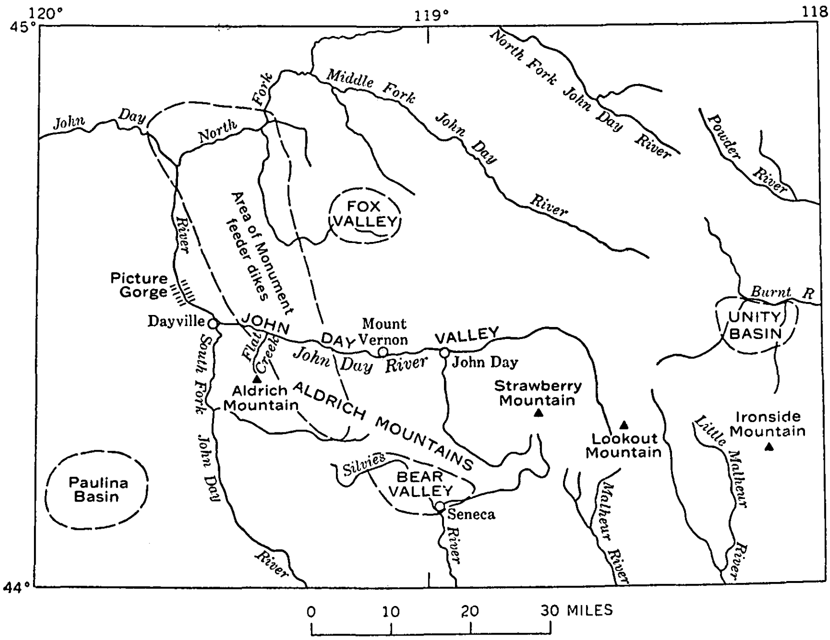

Figure 1.—Index map of the Canyon City quadrangle, Oregon.

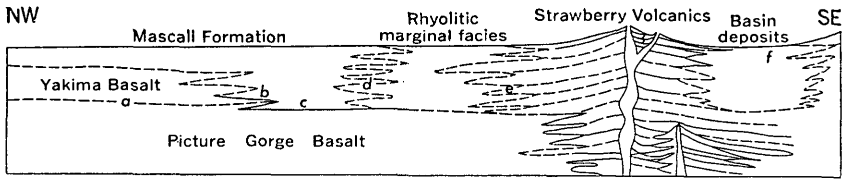

FIGURE 2.—Diagram showing known (solid lines) and inferred (dashed lines) stratigraphic relations between formations within the Columbia River Group and the stratigraphically equivalent Strawberry Volcanics in the Canyon City quadrangle, Oregon. Letters are referred to in text. Not drawn to scale.

Day Formation of late Oligocene to early Miocene age and on older rocks.

In the northwestern part of the Canyon City quadrangle the Columbia River Group consists of fissure flows of the Picture Gorge Basalt overlain, possibly unconformably, by other flows (*a–f*, fig. 2) regarded as Yakima Basalt by Waters (1961, p. 591). The Picture Gorge Basalt is about 1,500 feet thick at the type locality. At Flat Creek, 13 miles southeast of Picture Gorge, a 6,000-foot section of basalt flows seems to be related to piling up along Monument feeder dike swarm (Thayer and Brown, 1966); the upper flows very likely are equivalent to the Yakima Basalt. Along the western part of the John Day Valley the Mascall Formation reaches a maximum thickness of 2,000–3,000 feet (Merriam and others, 1925, p. 52; Thayer and Brown, 1966) and appears to lie conformably on all the basalt flows of the group (*c*, fig. 2). East of Mount Vernon we believe the Mascall interfingers (*d*, fig. 2) with the rhyolitic marginal facies which comprises basaltic and andesitic flows intercalated with rhyolitic waterlaid debris, welded tuffs and thick, lenticular rhyolite flows from local vents, and some conglomerate. Much of the fragmental rhyolitic debris in the marginal facies probably was derived from the Strawberry Volcanics to the east and south, and there is little doubt that the two units once interfingered (*e*, fig. 2). Around the western and southern margins of Fox Valley, waterlaid tuffs and conglomerates of the Mascall interfinger with thin basalt flows which are tentatively regarded as mostly equivalent to the Yakima Basalt, but which may include some flows of the Picture Gorge (*b*, fig. 2). In the John Day Valley the Mascall Formation is at least 1,000 feet thick where faulted against the 6,000-foot basalt section in Flat Creek, and only about 8 miles to the east it must originally have been at least 3,500 feet thicker (Thayer and Brown, 1966).

The Mascall Formation is believed by the authors to be a fluviatile basin facies derived from high-standing volcanic centers represented by the rhyolitic marginal facies and Strawberry Volcanics, to the south and east. Although the youngest beds preserved in the Mascall

Formation in the John Day Valley contain fossils only of late Miocene age, vertebrates from the Unity basin (*f*, fig. 2) indicate that the higher parts of the Strawberry Volcanics, and presumably the eroded upper part of the Mascall Formation, were deposited in early Pliocene time (J. A. Shotwell, written commun., 1964).

ALDRICH MOUNTAINS GROUP

By C. Ervin Brown and T. P. Thayer

The Aldrich Mountains Group (Brown and Thayer, 1966a) comprises the Upper Triassic and (or) Lower Jurassic rocks that form the eastern two-thirds of the Aldrich Mountains (fig. 3). The group includes four formations named, in order from oldest to youngest, Fields Creek Formation, Laycock Graywacke, Murderers Creek Graywacke, and Keller Creek Shale (fig. 4). The formations have a maximum aggregate thickness of about 35,000 feet, made up mostly of graywacke and shale, waterlaid volcanic tuff, siliceous mudstone and chert, and basaltic pillow lava. Because of the lenticular nature of the deposits, no type sections have been designated. A thick tongue of tuff in the Fields Creek Formation is named the Cinnabar Tuff Tongue, and a tongue in the Laycock Graywacke is named the Ingle Tuff Tongue.

FIELDS CREEK FORMATION

The Fields Creek Formation is named (Brown and Thayer, 1966a) for Fields Creek along the eastern side of the Aldrich Mountain quadrangle (fig. 3). The greatest known thickness of the formation is about 15,000 feet, in a section extending northeast across Fields Creek and the ridge north of Fields Peak. There the lower 10,000–11,000 feet of the formation is dominated by beds of siliceous mudstone, mostly less than a foot thick, and black shale. In the lowermost 4,000 feet, andesite flows, andesitic to dacitic volcanic breccia, lenticular rubbly conglomerate consisting mostly of reworked debris from Triassic rocks, lenses of slide breccia made up entirely of basement rocks, banded chert, and waterlaid ash are complexly intercalated.

A tongue of massive to obscurely bedded andesitic tuff, named the Cinnabar Tuff Tongue (Brown and Thayer, 1966b) for exposures on Cinnabar Mountain, is rich in pumiceous fragments and is about 3,500 feet thick there. It makes up most of the upper part of the formation and is now mainly a quartz-albite-chlorite rock spotted with authigenic prehnite (Brown and Thayer, 1963). The tuff thickens northeastward to about 8,500 feet and thins abruptly southeastward; locally, it grades upward into siliceous mudstone, shale, and graywacke.

The Fields Creek Formation lies unconformably on Paleozoic rocks, serpentinite, gabbro, and the Vester Formation. The top of the

Fields Creek in places is faulted off against, in places is unconformable with, and elsewhere grades into, the Laycock Graywacke.

The Fields Creek Formation is believed to be no older than late Late Triassic (N. J. Silberling, written commun., 1963), because transported blocks of reef limestone containing the brachiopod *Halorella* occur in shale in the basal part of the formation near Horseshoe Butte.

LAYCOCK GRAYWACKE

The Laycock Graywacke (figs. 3, 4) underlies most of the upper drainage basin of Laycock Creek, in the southeast quarter of the Mount Vernon quadrangle. Its thickest known section, from Laycock Creek to Fall Mountain, is estimated to be 11,000 feet. The lower part of the formation consists of coarse- to medium-grained graywacke and black shale. The upper part is more shaly and tuffaceous and grades westward into tuff and feldspathic graywacke of the Ingle Tuff Tongue (fig. 4), which is named for exposures in the headwaters of Ingle Creek and on the slopes of Ingle Mountain (Brown and Thayer, 1966b). The base of the formation is faulted off in Laycock Creek; to the west, the Laycock grades downward lithologically into the Fields Creek Formation with increasingly stronger folding. The formation is conformable with the overlying Murderers Creek Graywacke, which also is no older than late Late Triassic.

Massive lenses of graywacke of submarine slide origin are common in the Laycock Graywacke. These lenses are of dark-gray graywacke that contains a heterogeneous mixture of randomly distributed coarse lithic clasts. The graywacke weathers spheroidally and breaks through fragments as though the rock were fine grained and homogeneous. The matrix contains volcanic crystal debris. Rock from one of these lenses is quarried for road metal near the southeast corner of the Mount Vernon quadrangle.

The shale, siltstone, and graded graywacke of the Laycock are excellently exposed in roadcuts along U.S. Highway 395 in the Mount Vernon quadrangle and near the southwest corner of the John Day quadrangle.

MURDERERS CREEK GRAYWACKE

The Murderers Creek Graywacke (fig. 4) forms steep slopes along both sides of upper Murderers Creek (fig. 3), the type locality, in the southwest corner of the Mount Vernon quadrangle. There the formation ranges in thickness from 1,500 to 2,000 feet and consists almost entirely of medium- to fine-grained calcareous graywacke containing very little volcanic debris. Lenses of limestone breccia and breccia-conglomerate as much as 1,500 feet long and 120 feet thick occur locally at and near the base of the formation. Cobbles and blocks in the breccia generally range from 2 inches to 1 foot in maximum dimension, but a few blocks as long as 20 feet have been noted. The matrix of the breccia is calcareous silt studded with well-rounded pebbles of limestone, chert, quartz, mudstone, and volcanic rock. Although conformable to the underlying Laycock Graywacke, some channel-type erosion is associated with the limestone breccia lenses. In Riley Creek Butte the lowermost calcareous beds interfinger with tuff in the underlying Laycock Graywacke, but elsewhere, the contact marks a sharp change in lithology. Noncalcareous graywacke of the overlying rocks is conformable on the Murderers Creek Graywacke, except locally.

The age of the Murderers Creek Graywacke is not definitely known. The rocks cannot be older than late Late Triassic, because diagnostic Norian species of the ammonites *Placites*, *Sandlingites*, and *Vredenburgites* (N. J. Silbering, written commun., 1960) occur in blocks in the basal limestone breccia, and indigenous ammonites resembling Lower Jurassic forms have also been found (R. W. Imlay, oral commun., 1963).

KELLER CREEK SHALE

The Keller Creek Shale (figs. 1, 2) is best exposed in the headwaters of Keller Creek, in the northwest corner of the Logdell quadrangle. The formation is about 5,000 feet thick in the type locality. The lower 2,000–2,500 feet of the formation consists of massive to well-bedded coarse- to fine-grained tuffaceous graywacke, in which there are lenses of pebbly conglomerate, subordinate shale, and a few thin zeolitized (laumontite) ashy beds. In the middle and upper parts of the formation, gray to black shale interbedded with graywacke and siltstone in beds 1 inch to 1 or 2 feet thick is dominant; massive coarse- to fine-grained graywacke 500–1,000 feet thick occurs near the top of the formation. Elsewhere, the formation consists mostly of medium-bedded shale and siltstone. Although there is some evidence of local erosion of the underlying Murderers Creek Graywacke, the two formations appear to be for the most part conformable. A marked angular unconformity separates the Keller Creek Shale from overlying Lower Jurassic rocks.

Shales in the upper part of the formation have furnished *Arnioceras* of early Sinemurian age and *Crucilobiceras* and *Gleviceras* of late Sinemurian age, according to R. W. Imlay (written commun., 1965).

VESTER FORMATION

By C. Ervin Brown and T. P. Thayer

The Vester Formation is named (Brown and Thayer, 1966a) for exposures along the lower part of Vester Creek, a north-flowing tributary of Deer Creek in the north-central part of the Izee quadrangle (figs. 3, 4). The formation there comprises, in ascending order, about 6,000 feet of pebbly conglomerate and interbedded black shale, about 1,000 feet of waterlaid andesitic tuff, and 1,000 feet or more of dark shale. About 2 miles north of the type locality and 1 mile west of Buck Creek, interlayered ophitic basalt flows, flow breccia, and chert are included in the basal part of the formation. The conglomerate beds have a graywackelike matrix, commonly grade over short distances into graywacke and shale along the strike, and locally contain carbonized plant remains. The formation lies unconformably on Paleozoic schist and greenstone and Mesozoic serpentinite, diorite, and gabbroic rocks. North of Murderers Creek in the Aldrich Mountain quadrangle (Thayer and Brown, 1966), a major angular unconformity separates the conglomerate from the overlying Fields Creek Formation of the Aldrich Mountains Group; elsewhere, the conglomerate is in fault contact with younger rocks.

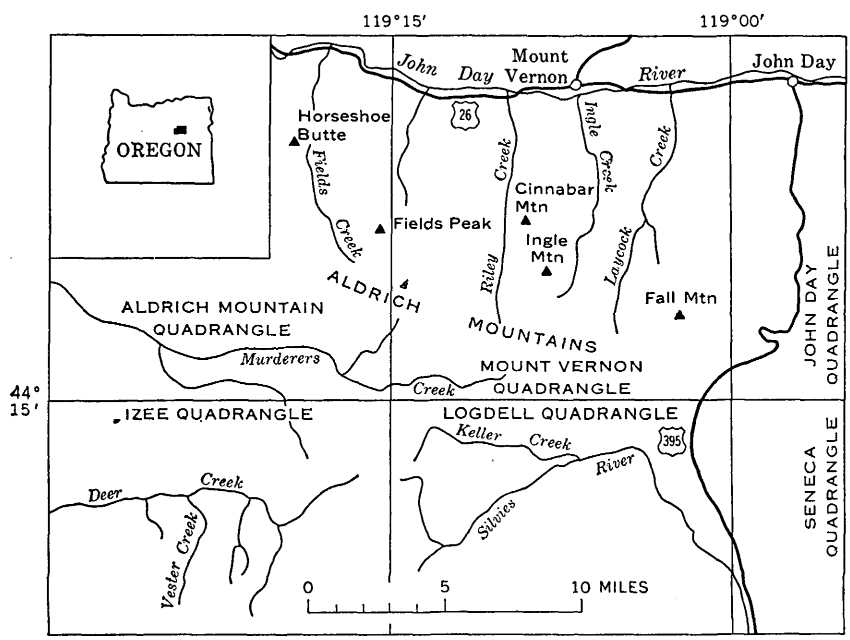

FIGURE 3.—Index map to localities in the vicinity of the Aldrich Mountains, Grant County, Oreg.

Fossils found in a small lens of limestone breccia, apparently transported, indicate that the formation is not older than late Karnian (middle Late Triassic) (N. J. Silberling, written commun., 1963).

System	Series		Name	Thickness (feet)		Lithology
JURASSIC	Lower Jurassic	Aldrich Mountains Group	Keller Creek Shale	5000±		Medium-bedded mudstone, shale, siltstone, massive volcanic graywacke, and waterlaid tuff; contains thin lenses of limestone breccia and cobbly mudstone in northern part of Izee quadrangle
TRIASSIC(?)	Upper Triassic(?)	Aldrich Mountains Group	Murderers Creek Graywacke	1500-2000		Buff-weathering calcareous graded graywacke and siltstone; lenses of limestone breccia and conglomerate locally at base; some blocks in breccia are 20 ft across. Basal beds are buff weathering calcareous siltstone and shale
			Local disconformity			
			Laycock Graywacke — Ingle Tuff Tongue	0-11,000	0-3000	Waterlaid dark-gray feldspar-rich andesitic tuff and tuffaceous graywacke
			Laycock Graywacke			Dark-colored and well-bedded graded graywacke, mudstone, and shale; includes submarine slide lenses of massive graywacke having a heterogeneous mixture of randomly distributed coarse lithic clasts
			Fields Creek Formation — Cinnabar Tuff Tongue	15,000	0-8500	Waterlaid andesitic massive tuff. Ranges from flint-textured bluish-gray rock to a coarse-grained dusky-brown rock containing pumice fragments. Tuff is now a quartz, albite, chlorite rock spotted with authigenic prehnite
			Fields Creek Formation			Dark-gray to black siliceous mudstone, shale, graded graywacke, and tuff. Near base are interbedded basaltic flows, ribbon chert, and breccia lenses of both volcanic and landslide origin
			Unconformity			
TRIASSIC	Upper Triassic		Vester Formation	8000		Massive conglomerate and well-bedded shale, graywacke, and andesitic tuff; interbedded basaltic flows and breccias near base

FIGURE 4.—Summary of Lower Jurassic and Upper Triassic rock units in the Aldrich Mountains, Oreg.

STOCKBRIDGE FORMATION

By E-an Zen

The carbonate rock unit that occurs in the valleys near Stockbridge and West Stockbridge, Mass., was named the Stockbridge Limestone by Emmons (1842, p. 154). Dale (1923) studied these rocks in more detail and subdivided the unit into a lower dolomitic member and an upper calcitic marble member. He continued to use the name Stockbridge Limestone for the carbonate units as a whole.

Recent detailed stratigraphic work in western Massachusetts by the author and others has shown the Stockbridge to be a heterogeneous rock group that could be and is being mapped into several stratigraphic units (Zen, 1964b). The highest beds of the Stockbridge, as used by Dale, are interbedded with the overlying schist unit, now called the Walloomsac Formation, and are hereby removed from the emended Stockbridge. The Stockbridge, as here restricted, can be divided into seven lithostratigraphic units; these units are provisionally designated by the letters A through G, from bottom to top (Zen and Hartshorn, 1966). Units A, B, C are dominantly dolostone but include, particularly in unit B, subsidiary but important beds of arkose and phyllite. Units D and F are heterogeneous and consist of silty limestone, dolostone, calcite marble, phyllite, and calcareous sandstone. The sandstone commonly shows prominent cross-stratification that allows the determination of stratigraphic tops. Units E and G are massive white to gray calcite marble, but locally they include interbedded pale massive fine-grained dolostone. Because of the lithic heterogeneity of the Stockbridge as a whole, it is here redesignated as the Stockbridge Formation; it excludes the highest beds of the Stockbridge Limestone interbedded with the overlying schist unit. Although the type locality is in the quarries in and around the town of Stockbridge, excellent and definitive sections can be seen in the Egremont quadrangle, Massachusetts-New York, at Vossburg Hill and on the hillside south of the village of South Egremont.

The Stockbridge Formation has not yielded fossils. However, the base of unit A grades downward into the Lower Cambrian Cheshire Quartzite, as can be seen at Vossburg Hill, through interbedding and through the acquisition of carbonate cement in the quartzite. The highest beds of the Stockbridge Limestone of Dale that interbed with the basal part of the Walloomsac Formation and overlie the Stockbridge Formation contain corals of Middle Ordovician age (Zen and Hartshorn, 1966). The Stockbridge Formation thus spans the age between Early Cambrian and Early or Middle Ordovician.

WALLOOMSAC FORMATION

By E-an Zen

Prindle and Knopf (1932, p. 274) applied the name Walloomsac Slate to a unit of gray and black slate in the Taconic quadrangle of southwestern Vermont, northwestern Massachusetts, and eastern New York. The rock is Middle Ordovician, as shown by contained graptolites (Prindle and Knopf, 1932, p. 274; Potter, 1963, p. 62). The rock can be mapped continuously from its type locality (along the Walloomsac River) to southwestern Massachusetts and adjacent Connecticut. In the latter areas, however, rising metamorphic grade has changed the rock to a schist, including extensive areas of almandine-staurolite-biotite schist (Zen and Hartshorn, 1966). The designation of "slate" is therefore inappropriate, and the unit is hereby formally designated the Walloomsac Formation.

The uppermost beds of the Stockbridge Limestone as used by Dale (1923) are interbedded with the basal part of the schist of the Walloomsac and are now included within the Walloomsac Formation (Zen and Hartshorn, 1966). These limestone beds range from a few inches to several tens of feet thick and from silty, gray, and thin bedded to massive and white. One bed of this limestone near Pittsfield, Mass., has yielded corals no older than Black River in age (Zen and Hartshorn, 1966). This, then, is the age of the basal part of the Walloomsac Formation, in agreement with the age indicated by the graptolites.

EGREMONT PHYLLITE

By E-an Zen

Hobbs (1893, p. 727) applied the name Egremont Limestone to the carbonate rocks of the Housatonic valley in southwestern Massachusetts and northwestern Connecticut, as well as to other rock types that occur in the Taconic Range just to the west. Hobbs described the latter types as follows: "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."

Hobbs (1897, p. 177) later realized that the bulk of his Egremont Limestone, occurring in the Housatonic valley, is part of the Stockbridge Limestone as the name was used by Dale (1891). He therefore restricted the name Egremont to the rock types of the "summit plains" and referred them to the Bellowspipe Limestone as defined by Dale (1891). These rocks have been called the Berkshire Schist by Emerson (1917) and Dale (1923); they were lumped with the Everett Schist by Fisher and others (in New York State Mus. and Sci. Service, Geol. Survey, 1962). The evolution of nomenclature and its implications was summarized by Zen (1964a, p. 35).

Recent study of the bedrock geology of the Bashbish Falls and Egremont quadrangles in southwestern Massachusetts by the author shows that Hobbs' original "summit plains" phase of the Egremont is a mappable unit. It is a gray to black phyllite, locally carrying interbedded phyllitic marble. This sequence resembles the Walloomsac Formation; the two units also hold similar relations to the overlying Everett Formation. However, the correlation of the Walloomsac with the "summit plains" phase of the Egremont cannot be proven, owing to structural complications. For this reason, the "summit plains" phase of the Egremont is hereby designated the Egremont Phyllite; it is of uncertain age, although probably early Paleozoic and possibly Middle Ordovician. The type locality is in Egremont town, Massachusetts (Egremont quadrangle), where excellent exposures can be seen in Karner Brook.

EVERETT FORMATION

By E-an Zen

Hobbs (1893, p. 728) applied the name Everett Schist to the green schist that occupies the higher parts of the Taconic Range in southwestern Massachusetts and northwestern Connecticut. The type locality is Mount Everett, the highest peak in the Taconic Range of this area, in the Bashbish Falls quadrangle. The rock in the type area has since been referred to as the Berkshire Schist (Hobbs, 1897, p. 177; Gregory and Robinson, 1907, p. 33; Emerson, 1917, p. 39; Weaver, 1957, p. 746) or the Salisbury Schist (Agar, 1932, p. 38; Rodgers and others, 1959, p. 9); Fisher and others (in New York State Mus. and Sci. Service, Geol. Survey, 1962), however, retained the name Everett Schist.

Both the names Berkshire and Salisbury, as used in the earlier works, include gray schists and phyllites which are now mapped with the Middle Ordovician Walloomsac Formation (Zen and Hartshorn, 1966). It is here proposed, therefore, that the name Everett be used to apply to the predominantly green and gray-green schists and phyllites that structurally overlie the Walloomsac. The Everett as here used, however, includes ancillary local rock types, including massive graywacke, sandstone, and gray schist (Zen and Hartshorn 1966). For these reasons, and because different metamorphic grades cause the rock to range from a slate to a staurolite-almandine schist at different localities, the rock unit is referred to as the Everett Formation. The type locality is Mount Everett. The age is considered to be Cambrian(?), Cambrian, or Ordovician.

REDEFINITION OF THE ROWE SCHIST IN NORTHWESTERN MASSACHUSETTS

By N. L. Hatch, Jr., A. H. Chidester, P. H. Osberg, and S. A. Norton

Work done in cooperation with the Massachusetts Department of Public Works

Recent mapping by the authors in the Rowe, Heath, Plainfield, and Windsor quadrangles in northwestern Massachusetts has indicated the desirability of redefining the Rowe Schist (Emerson, 1898, p. 76–78) [1] to include all the rocks in the interval between the top of the Hoosac Schist and the base of the Moretown Formation. As originally mapped by Emerson, the Rowe included the succession of mica schists between the top of the Hoosac Schist (Pumpelly and others, 1894, p. 23–97; Emerson, 1898, p. 66–76) and the base of the Chester Amphibolite (Pumpelly and others, 1894, p. 29–30; Emerson, 1898, p. 78–155). (See fig. 5.)

Mapping has shown that amphibolite mapped by Emerson (1898, pl. XXXIV; 1917, pl. X) as one continuous unit is actually a series of beds distributed over a considerable stratigraphic interval. Moreover, other lithologically indistinguishable and locally thicker amphibolites and greenstones are present both above and below those mapped by Emerson as Chester Amphibolite. Thus, not only is the Chester of doubtful usefulness or validity as a formation, but the upper contact of the Rowe Schist becomes a tenuous boundary. Furthermore, the mapping shows that the upper part of the Savoy Schist (Emerson, 1898, p. 156–163) is equivalent to the Moretown Formation of Vermont (Cady, 1956) [2] and that the lower part of the Savoy Schist correlates with the Stowe and Ottauquechee Formations of the Vermont section (fig. 5).

In the area of the present study, three distinctive types or associations of rocks are recognized throughout the interval between the top of the Hoosac Schist and the base of the Moretown Formation: (1) Green or greenish-gray quartz-muscovite-chlorite-(albite-magnetite-garnet) schists make up roughly 75 percent of this stratigraphic interval; these schists are identical to and in part continuous with rocks mapped as Pinney Hollow and Stowe Formations in southern Vermont (Doll and others, 1961). Nearly equal parts of (2) gray and black graphitic phyllite, quartz-mica schist, and quartzite, and (3) amphibolite (or greenstone) constitute the remainder of the interval. Detailed mapping demonstrates that the graphitic rocks (lithologically similar to the Ottauquechee Formation of Vermont) and the amphibolites each form several units within this stratigraphic

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[1] The Rowe Schist, as well as the Hoosac Schist, Chester Amphibolite, and Savoy Schist, was first named by Emerson in 1892 (unpub. data).

[2] Mapped as the Moretown Member of the Missisquoi Formation by Doll and others (1961), and so shown here in figure 5.

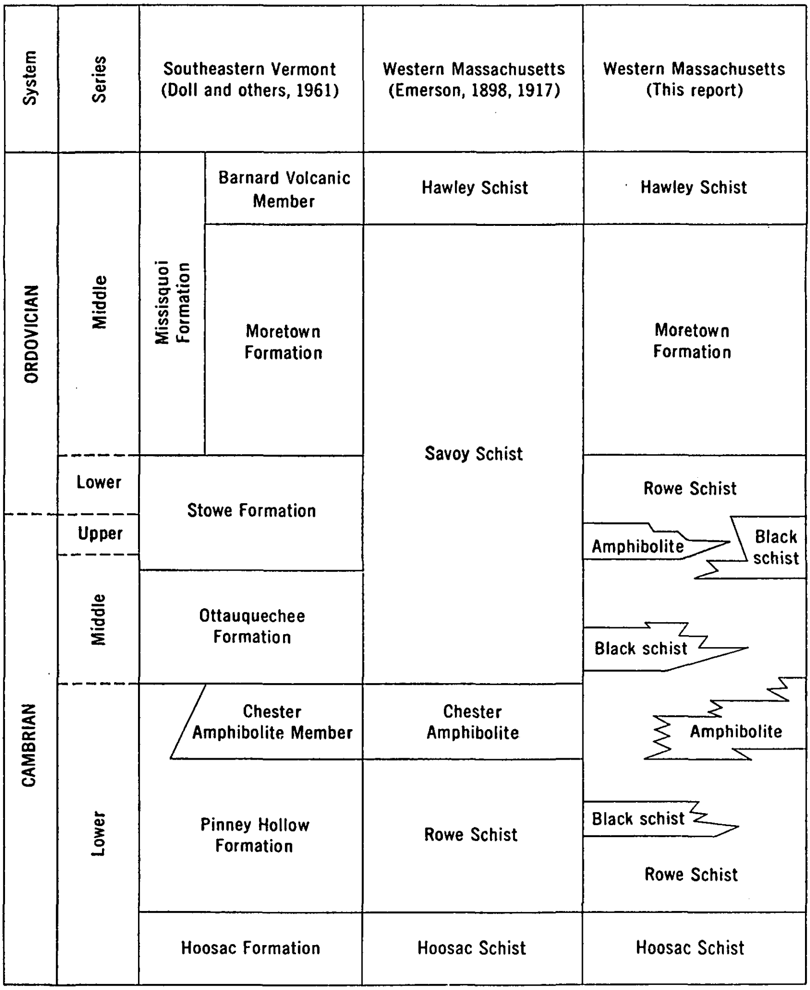

FIGURE 5.—Correlation of rock units of western Massachusetts (Emerson, 1898, 1917), this report, and southeastern Vermont (Doll and others, 1961).

interval, and that some of the units appear to be discontinuous and not mappable for more than 5 miles along strike.

The Rowe Schist is here redefined to include all the rocks in the interval between the top of the Hoosac and the base of the Moretown (fig. 5). It includes all of Emerson's original Rowe Schist plus his Chester Amphibolite and the lower, more schistose parts of his Savoy Schist. In terms of the Vermont section, the Rowe includes the equivalents of the Pinney Hollow Formation and its Chester Amphibolite Member, plus the Ottauquechee and Stowe Formations. The Chester Amphibolite should be retained as a member of the Rowe

Schist, but the term should be applied only to proven continuations of the amphibolite at the type locality in Chester, Mass.

The boundary of the redefined Rowe with the underlying Hoosac Schist is mapped primarily on the basis of texture, with secondary emphasis on mineralogy and color. The lower part of the Rowe consists of green or light-gray fine-grained quartz-muscovite-chlorite-(albite-magnetite) schist and phyllite in which bedding rarely is distinguishable. The underlying Hoosac schists are coarser grained, more granular, gray, brown, or green, composed primarily of quartz, albite, muscovite, biotite, and(or) chlorite, and generally are characterized by distinct beds ½–6 inches thick. The upper boundary of the Rowe is placed at the base of the lowest beds of pale-green or buff quartz-feldspar-mica granulite or of granular quartz-feldspar-mica schist containing continuous ⅛- to ¼-inch beds of quartzite, both characteristic of the Moretown Formation. This usage of the term Rowe is consistent with that of Herz (1961) in the adjacent North Adams quadrangle where only the lower and middle parts of the formation are present.

Within the area studied to date (1965), the thickness of the redefined Rowe Schist is about 1,000 feet at the Vermont-Massachusetts State-line and at least 5,000 feet in the town of Florida, Mass. The formation includes rocks ranging in age from Early Cambrian to Late Cambrian or possibly Early Ordovician.

PRECAMBRIAN AND LOWER CAMBRIAN FORMATIONS IN THE DESERT RANGE, CLARK COUNTY, NEVADA

By JOHN H. STEWART and HARLEY BARNES

More than 10,000 feet of conformable Precambrian and Lower Cambrian strata have been measured in the Desert Range, Clark County, Nev. (fig. 6). The section is one of the thickest, most complete, and best exposed of this age strata in the southern Great Basin. The area studied lies 40–50 miles north-northwest of Las Vegas within a belt of Precambrian and Lower Cambrian outcrops extending for nearly 20 miles along the west side of the Desert Range from Clark County northward into Lincoln County, Nev. Because the area is within the Nellis Air Force Range, it was accessible only on weekends. In all, 7 days were spent in reconnaissance of the area and in measuring the section.

The exposed strata measured belong to a conformable sequence consisting of the Johnnie Formation and Stirling Quartzite of Precambrian age, the Wood Canyon Formation of Precambrian and Early Cambrian age, and the Zabriskie Quartzite of Early Cambrian age. The Carrara Formation of Early and Middle Cambrian age

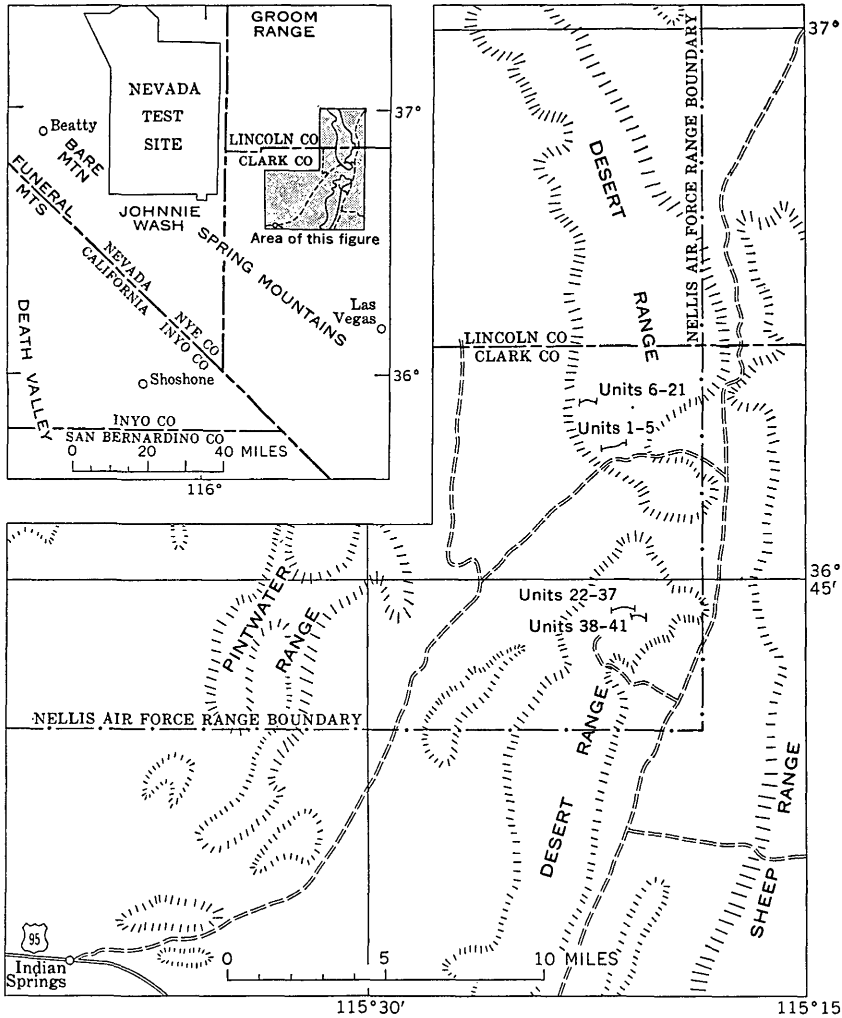

FIGURE 6.—Index map and location of measured sections.

is also exposed, but its thickness was not measured. On the geologic map of Clark County (Bowyer and others, 1958), these strata were included in (1) the "Stirling quartzite and Johnnie formation, undifferentiated," which was classified at that time as Early Cambrian in age, and (2) a "quartzite, shale and limestone" unit (including the Wood Canyon Formation) of Early and Middle Cambrian age. On the Lincoln County geologic map (Tschanz and Pampeyan, 1961) the strata were included in the Johnnie Formation and Prospect Mountain Quartzite, both classified at that time as Early Cambrian in age. The age designations used in this report follow the more recent classification of Barnes, Christiansen, and Byers (1965).

JOHNNIE FORMATION

The Johnnie Formation in the Desert Range consists of a variety of lithologic types, including quartzite, some of which is conglomeratic, siltstone, limestone, and dolomite (fig. 7). It is divided into five major members (fig. 7), which are, in ascending order: (1) carbonate member, (2) lower quartzite and siltstone member, (3) siltstone and carbonate member, (4) upper quartzite and siltstone member, and (5) a limestone and siltstone member (Rainstorm Member). The Rainstorm Member was named by Barnes and others (1965) for outcrops in the northeastern part of the Nevada Test Site (fig. 6); the other names are informal.

The base of the Johnnie Formation is not exposed in the Desert Range, but the exposed section is about 5,200 feet thick, making it the thickest known section of the Johnnie. The next thickest section known (4,500 ft) is in the type area of the formation near Johnnie Wash in the northwestern part of the Spring Mountains (Nolan, 1929; Burchfiel, 1964), but there also the base of the formation is not exposed. The contact of the Johnnie Formation with the underlying Noonday Dolomite is exposed in the southern part of the Nopah Range, but the Johnnie is less than 2,500 feet thick at that locality (Hazzard, 1937; Stewart, 1966).

The lower 2,850 feet of the Johnnie Formation exposed in the Desert Range—the lower three members of this paper—appears to correlate approximately with the lower 2,800 feet of the type Johnnie exposed near Johnnie Wash. The details of this correlation, however, are uncertain. These members in the Desert Range contain abundant fine- to medium-grained quartzite, whereas the presumably comparable strata in the Spring Mountains contain considerably less quartzite, which is predominantly fine grained. A chert-bearing dolomite unit, nearly 100 feet thick, which lies about 2,000 feet below the top of the Johnnie Formation near Johnnie Wash, probably correlates with a lithologically similar chert-bearing dolomite (fig. 7, unit 10) in the Desert Range. The upper quartzite and siltstone member of the Johnnie Formation in the Desert Range seems to correlate with a conspicuous quartzite sequence lying 900–1,700 feet below the top of the Johnnie Formation near Johnnie Wash.

The Rainstorm Member, which consists of pale-red to grayish-red laminated limestone and minor amounts of limestone and very fine grained quartzite, has been recognized over an extensive area of the Great Basin, including the Groom area (Barnes and Christiansen,

System	Formation	Member	Unit	Thickness (feet)	Description
PRECAMBRIAN			22		Same as unit 22 in figure 8
	Stirling Quartzite	Rainstorm Member (936 ft)	21	210	Grayish-olive and grayish-purple (top 60 ft) siltstone and pale-yellowish-brown very fine grained laminated quartzite. One-ft-thick sandy dolomite 5 ft below top
	Johnnie Formation (about 5200 ft exposed)	Rainstorm Member (936 ft)	20	650	Pale-red to grayish-red evenly laminated limestone, silty limestone, limy siltstone, and siltstone. Intergrading lithologic types. Common ripple marks, drag(?) marks, and possible flute casts
			19	6	Grayish-orange-weathering oolitic dolomite
			18	70	Grayish-olive siltstone
		Upper quartzite and siltstone member (1435 ft)	17	345	Pale-red-purple fine- to coarse-grained commonly cross-stratified quartzite and grayish-purple and grayish-olive siltstone. Rare conglomeratic quartzite (pebbles as large as 0.5 in.). Two-ft-thick layer of dolomite 60 ft above base
			16	350	Pale-red-purple fine- to medium-grained cross-stratified quartzite. Top third of unit contains a few layers of granule conglomerate
			15	180	Light-olive-gray fine-grained laminated to very thin bedded quartzite and minor amounts of pale-olive siltstone
			14	90	Grayish-olive siltstone and common yellowish-gray fine-grained quartzite in lower 25 ft. Some granule conglomerate in lower 10 ft
			13	470	Grayish-red-purple fine- to medium-grained cross-stratified quartzite. Rare grayish-red-purple siltstone in lower two-thirds of unit. Rare conglomerate (pebbles as large as 0.5 in.) in top 110 ft
			12	50	Grayish-olive siltstone and rare greenish-gray fine- to medium-grained quartzite
		Siltstone and carbonate member (785 ft)	11	70	Greenish-gray fine- to medium-grained quartzite
			10	155	Medium-gray aphanitic to very finely crystalline dolomite. Irregular chert nodules 10 ft below top
			9	230	Greenish-gray coarse siltstone to very fine grained sandstone. Minor amounts of yellowish-gray and greenish-gray fine- to medium-grained quartzite
			8	85	Greenish-gray and yellowish-gray fine- to medium-grained indistinctly bedded quartzite and dark-greenish-gray and grayish-olive siltstone
			7	105	Dark-greenish-gray and grayish-olive siltstone
		Lower quartzite and siltstone member (1645 ft)	6	90	Medium-gray to dark-gray very finely crystalline laminated limestone
			5	80±	Pale-yellowish-brown medium- to coarse-grained thin-bedded quartzite to conglomeratic quartzite. Conglomeratic parts contain granules and small pebbles. Minor amounts of pale-olive and yellowish-gray siltstone
			4	1125	Light-olive-gray fine- to medium-grained laminated to thin bedded and cross-stratified quartzite. Rare medium- to coarse-grained parts. Grayish-olive siltstone in layers from 1 in. to 40 ft thick common. Two-ft-thick dolomite 525 ft above base
			3	440±	Very pale orange and pale-yellowish-brown very fine to fine-grained quartzite and pale-olive to grayish-olive siltstone. Quartzite dominant in lower part; siltstone dominant in upper part. Dolomitic limestone occurs from 15 to 20 ft above base, dolomitic sandstone from 20 to 30 ft below top. Unit probably cut by several faults; thickness may be in error
			2	340	Medium-gray very pale orange and pale-yellowish-brown very fine to medium crystalline laminated to very thin bedded limestone and rare dolomite. Common sandy limestone containing very fine to very coarse quartz grains. Minor amounts of yellowish-gray to pale-yellowish-brown fine- to medium-grained quartzite
		Carbonate member (420 ft)	1	80+	Pale-yellowish-brown to medium-gray very fine to fine-grained quartzite to sandstone. Rare light-greenish-gray siltstone. Minor amounts of medium-dark-gray limestone in top 30 ft

FIGURE 7.—Incomplete columnar section of the Johnnie Formation, Desert Range, Clark County, Nev.

written commun., 1966) Nevada Test Site (Barnes, Christiansen, and Byers, 1965) and the Spring Mountains-Death Valley region (Stewart, 1966). It constitutes the top 900 feet of the Johnnie Formation near Johnnie Wash. A thin and conspicuous grayish-orange-weathering oolitic dolomite (fig. 7, unit 19) occurs about 70 feet above the base of the Rainstorm Member in the Desert Range. This unit, informally referred to as the "Johnnie oolite," is remarkably persistent and homogeneous; it has been recognized at the Nevada Test Site (Barnes, Christiansen, and Byers, 1965) and throughout the Spring Mountains-Death Valley region (Wright and Troxel, 1966; Stewart, 1966).

STIRLING QUARTZITE

The Stirling Quartzite consists of quartzite, minor amounts of which are conglomeratic, minor siltstone, and a few layers of limy sandstone and dolomite (fig. 8). Four informal members are recognized in the formation in the Desert Range and correlated with members recognized widely by Stewart (1966) in the Spring Mountains-Death Valley region. Following the informal designations used by Stewart in the Spring Mountains-Death Valley region, the members in the Desert Range are referred to, in ascending order, as the A, B, C, and E members. The D member, widely distributed in the Spring Mountains-Death Valley region, is not recognized in the Desert Range.

The A member of the Stirling Quartzite in the Desert Range is a cliff-forming unit composed predominantly of fine- to medium-grained cross-stratified quartzite. It is coarse grained and conglomeratic in part and contains some siltstone. The B member is a slope-forming unit composed of indistinctly laminated, generally very fine grained quartzite, grading upward into fine- to medium-grained quartzite. The C member is grayish red purple; the lower 245 feet are slope-forming siltstone and fine-grained quartzite, the upper 360 feet predominantly fine- to medium-grained laminated quartzite. The E member is generally light colored and consists predominantly of fine- to medium-grained cliff-forming quartzite. Minor amounts of limy sandstone occur from 140–275 feet above the base of the E member, and a conspicuous slope-forming unit of siltstone, quartzite, and rare dolomite occurs from 275–395 feet above the base of the member. The top 470 feet of the E member forms a prominent cliff. The Stirling Quartzite is about 3,100 feet thick in the Desert Range.

The A, B, and C members recognized in the Desert Range are lithologically similar to the corresponding A, B, and C members recognized by Stewart (1966), but correlation of the D and E members of the Spring Mountains-Death Valley region with units in the Desert Range is less certain. The D member, largely dolomite on Bare Mountain and in the Funeral Mountains, grades out to the east within the Spring Mountains-Death Valley region into quartzite of the basal part of the E member and therefore probably does not extend as far east as the Desert Range. The limy sandstone and dolomite of units 31 and 32 of the E member (fig. 8) might be tongues of the dolomitic D member to the west, but this correlation seems unlikely because these carbonate beds in the Desert Range occur above 140 feet of light-colored fine- to medium-grained quartzite (unit 30)

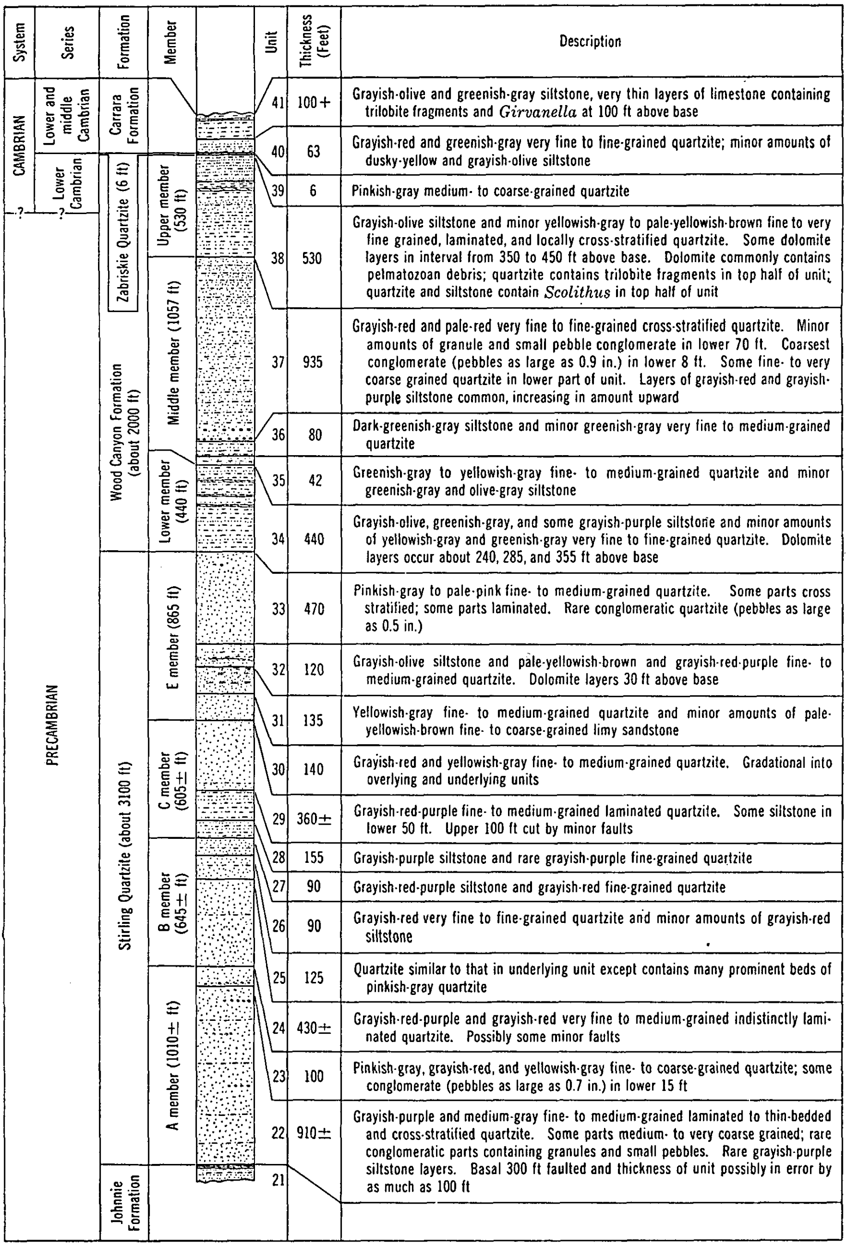

FIGURE 8.—Columnar section of the Stirling Quartzite, Wood Canyon Formation, and Zabriskie Quartzite, Desert Range, Clark County, Nev.

typical of the strata that elsewhere occur in the basal part of the E member above the D member. The top 865 feet of the Stirling Quartzite in the Desert Range is correlated with the E member, a member characteristically composed mostly of quartzite. This correlation is based on the lithologic similarity of the quartzite in this part of the Stirling in the Desert Range with quartzite in the E member at other places.

Barnes and Christiansen (written commun., 1966) recognize members A, B, C, and E of the Stirling Quartzite in the Groom Range, about 45 miles northwest of the central Desert Range (fig. 6). They further subdivide member E in the Groom Range into three lithologic units. Their unit 1 of member E corresponds lithologically to our combined units 30 and 31 in the Desert Range, their unit 2 correlates with our unit 32, and their unit 3 correlates with our unit 33.

WOOD CANYON FORMATION

The Wood Canyon Formation is divided into three parts referred to informally as the lower, middle, and upper members (fig. 8). The lower member consists of siltstone, minor amounts of quartzite, and a few layers of dolomite. The middle member consists predominantly of very fine grained to fine-grained quartzite. In addition, medium-grained to very coarse grained quartzite and conglomerate occur in the lower third of the middle member, and thin siltstone layers occur throughout. The upper member consists of siltstone and minor amounts of quartzite and dolomite. The dolomite is in the upper half of the upper member and contains abundant pelmatozoan debris. Also present in the upper half of the upper member are trilobite fragments in quartzite and *Scolithus* (worm-borings) in siltstone and quartzite. The fossils in this member represent the lowest occurrence of fossils in the Desert Range area and correspond to the lowest occurrences of fossils, excluding algal structures, in the Precambrian and Lower Cambrian sequence of the Spring Mountains-Death Valley region (Hazzard, 1937; Wright and Troxel, 1966; Stewart, 1966), of the Nevada Test Site area (Barnes, Christiansen, and Byers, 1965), and of the Groom Range (Barnes and Christiansen, written commun., 1966). The three members recognized in the Wood Canyon Formation in the Desert Range are correlative with the three members of the formation in each of these areas. The Wood Canyon Formation is about 2,000 feet thick in the Desert Range.

ZABRISKIE FORMATION

A 6-foot layer of medium- to coarse-grained quartzite in the Desert Range is identified as the Zabriskie Quartzite (fig. 8). This correlation is assured by the coarseness of the unit and by its occurrence above a dominantly siltstone unit of the Wood Canyon Formation and below a quartzite and siltstone unit in the basal part of the Carrara

Formation. The same lithologic features and stratigraphic relations characterize the Zabriskie Quartzite elsewhere.

Only the basal part of the Carrara Formation has been studied in the Desert Range area. The basal 63 feet (fig. 8, unit 40) of the formation consists of micaceous quartzite and minor amounts of micaceous siltstone. Overlying this unit is an unmeasured sequence of siltstone and limestone. Trilobite fragments and the algal structure *Girvanella* occur in limestone layers about 100 feet above the base of the siltstone and limestone sequence.

PUDDLE SPRINGS ARKOSE MEMBER OF WIND RIVER FORMATION

By Paul E. Soister

Name And Type Area

The Puddle Springs Arkose Member is herein named for exposures near Puddle Springs Ranch in the south-central Wind River Basin, Wyo. This thick arkose, which contains virutally all the known uranium deposits of the Gas Hills district of Fremont and Natrona Counties, has heretofore been termed the upper coarse-grained facies of the Wind River Formation (Zeller and others, 1956; Soister, 1958); however, as the arkose differs lithologically from the bulk of the Wind River Formation over most of this basin, its designation as a separate member is desirable. Forthcoming reports by the present author showing more details of this member include maps of the Coyote Springs, Muskrat Basin, Puddle Springs, and Rongis Reservoir SE quadrangles, and a comprehensive report on stratigraphy of the Wind River Formation in the south-central Wind River Basin.

The type area designated for the member is bounded on the west by Puddle Springs Ranch and Coyote Springs, on the east by Willow Springs Draw, on the north (base of member) by sec. 19, T. 33 N., R. 90 W., and on the south (top of member) by sec. 8, T. 32 N., R. 90 W.

A type locality or section is not designated because (1) the entire member is not exposed in one complete section; (2) as a result of numerous lateral variations, no single stratigraphic section is completely representative of the member; and (3) exposures are poor in much of the region.

Occurrence And Facies Relations

In the south-central Wind River Basin, the Wind River Formation consists of a lower fine-grained variegated (green and gray with red bands) member, 0–130 feet thick; the Puddle Springs Arkose Member, about 400–800 feet thick; and an upper transition zone, generally

50–100 feet thick. Numerous composite sections including drill-hole logs have been compiled, particularly on the Puddle Springs.

The Puddle Springs Arkose Member crops out along the base of the Beaver Rim escarpment and a few miles out into the Wind River Basin, but it has been entirely removed by Quaternary erosion in areas farther north. It is almost entirely coarse arkose between Muskrat Creek and the vicinity of East Canyon Creek. Farther west toward the east flank of the Conant Creek anticline, and east to the Rattlesnake Range, arkose is interbedded with very numerous partly variegated beds similar to those in the lower member. North of those areas in which the entire formation has been removed by erosion, coarse arkosic sandstone beds interbedded in predominantly fine-grained sediments are probably tongues from the Puddle Springs.

Lithology, Origin, And Thickness

The Puddle Springs Member consists mainly of massive coarse-grained to very coarse grained arkosic sandstone and granite granule-to-boulder conglomerate. It has thin beds of finer grained feldspathic to arkosic sandstone, siltstone, claystone, and sparse thin beds of carbonaceous shale; carbonized and silicified wood are common locally. Most of the fine-grained beds are less than 10 feet thick.

The sediments were derived principally from the ancestral Granite Mountains, south of the Wind River Basin, and were deposited on a piedmont alluvial fan and in related environments. The surface on which the Wind River Formation was deposited had a maximum relief of more than 1,300 feet, and was cut on rocks ranging in age from Paleocene to Cambrian or Precambrian.

The member has a maximum thickness of generally about 400–800 feet, but it thins to zero by overlap onto the highlands.

Mapped Subunits

Three conglomerate beds in the Puddle Springs Arkose Member have been mapped. Poor exposures preclude extensive mapping of other subunits.

The East Canyon Conglomerate Bed, herein named from exposures along East Canyon Creek, is a long narrow tonguelike deposit about 2–3 miles wide and more than 15 miles long whose long axis is almost due north along the Fremont-Natrona County line. Type locality of the bed is in the W½SW¼NE¼ sec. 4, T. 33 N., R. 89 W., in the Ervay Basin SW quadrangle. Here, 130 feet of predominantly granite cobble-boulder conglomerate with a coarse sandy matrix is divided by a middle sandstone layer 23 feet thick; the sandstone probably grades southward to conglomerate. On outcrops, boulders average 1½ feet in diameter but some are as large as 4 feet. The East Canyon was traced in drill holes southward from its type locality and was found in scattered outcrops northward for a few miles where exposures are poor. At its type locality, the bed rests directly on the Cody Shale of Late Cretaceous age, but in the subsurface its base is locally as much as 100 feet above the base of the Wind River Formation. The lower fine grained member of the formation is apparently absent because of intraformational erosion in the area of occurrence of the East Canyon Conglomerate Bed. Locally, the top of the bed is difficult to recognize because of coarseness of the overlying arkose. The bed has an average subsurface thickness of about 300 feet south of its outcrop; a maximum thickness of 700 feet was penetrated in a drill hole 800 feet deep, in the NE¼SW¼ sec. 27, T. 33 N., R. 89 W. (H. D. Zeller, oral commun., 1958.)

The other two conglomerate beds, in the west half of the area, are thin and sheetlike where they crop out.

The Dry Coyote Conglomerate Bed, herein named from excellent exposures along Dry Coyote Creek, may be approximately equivalent to the uppermost part of the East Canyon Conglomerate Bed. The N½SE¼SW¼ sec. 6, T. 32 N., R. 90 W., is designated the type section of the Dry Coyote. It can be traced from Willow Springs Draw to near Muskrat Creek, and possibly equivalent lenses are as far as about 5 miles west of Muskrat Creek. Stratigraphically, the Dry Coyote Conglomerate Bed is just below the middle of the formation. At its northern eroded edge in sec. 29, T. 33 N., R. 90 W., it lies about 320 feet above the base of the Puddle Springs Member; however, as a result of overlap on the pre-Wind River erosion surface, it rests on the Mowry Shale of Early Cretaceous age about 4½ miles to the southwest at Coyote Springs and is locally absent where hills of other pre-Wind River rocks protruded above its plain of deposition farther southwest. This is a granite cobble-boulder conglomerate bed with a coarse sandy matrix and some lenses of coarse arkosic sandstone. Boulders average 1–1½ feet in diameter, but some are as large as 3 feet. Carbonaceous material is common in and just above this bed. The bed is about 20 feet thick at the type locality and is persistently 10–30 feet thick in outcrops; it thickens to the southeast toward and beyond the head of Dry Coyote Creek and is more than 50 feet thick in the subsurface in the SW¼SE¼ sec. 7, T. 32 N., R. 90 W. Uranium mineral occurrences are numerous in and near this bed, and many large uranium deposits occur stratigraphically near it; this bed could be an excellent local marker bed in uranium exploration.

The Muskrat Conglomerate Bed, herein named from very good exposures at Muskrat Creek in secs. 10, 15, 16, 20, and 21, T. 32 N., R. 91 W., is about 100 feet above the Dry Coyote Conglomerate Bed. The SE¼SW¼SE¼ sec. 10, T. 32 N., R. 90 W., is designated the type locality of the bed. It can be traced from its apparent east edge just west of Coyote Creek at Coyote Springs almost to the Conant Creek anticline, west of the mapped area. The Muskrat is 100 feet above the Dry Coyote and lies stratigraphically a short way above the middle of the formation; however, owing to overlap on the pre-Wind River erosion surface, the bed rests on the Cloverly Formation of Early Cretaceous age in sec. 20, T. 32 N., R. 91 W., and is near the base of the formation in other localities south of its outcrop. The Muskrat is 19.5 feet thick at its type locality and is generally 10–20 feet thick along its outcrop. This bed is a cobble-boulder conglomerate which consists mostly of granite, but which also contains abundant metamorphic rocks, especially gneiss. Boulders 2–6 feet in diameter are common, and the largest noted was 13 feet long. In general, both the matrix and underlying and overlying beds are finer grained than those of the Dry Coyote Conglomerate Bed, and mud balls as much as 3 feet in diameter were seen east of Muskrat Creek. An origin partly by mudflow may be postulated for the conglomerate on the basis of this evidence.

Contacts

Coarse-grained calcareous arkosic sandstone beds a few feet thick mark the contact of this member with the underlying lower fine-grained member in the vicinity of Puddle Springs. Farther east, toward the west flank of the Dutton Basin anticline, the base rises by interbedding of arkose with numerous stratigraphically higher fine-grained beds. Between Willow Springs Draw and the anticline, a carbonaceous shale and coal zone 5–15 feet thick, hereinafter termed "the central carbonaceous zone," immediately underlies the Puddle Springs Arkose Member and is the base of the richest known uranium ore zone of the district.

East and south of the Dutton Basin anticline, and along the south edge of the area of exposure, the Puddle Springs Arkose Member rests on rocks ranging in age from Late Cretaceous to Mississippian; farther south it may rest on Cambrian and Precambrian rocks. Just west of the Rattlesnake Range, a thick lower fine-grained member may underlie the exposed interbedded arkose and fine variegated beds.

The top of the Puddle Springs Arkose Member is placed at the base of the lowest of several tuffaceous sandy mudstone beds, 5–20 feet thick, which are interbedded with coarse arkosic sandstone beds. Inasmuch as the mudstone is similar to that in the overlying Eocene Wagon Bed Formation, the zone of interbedding was informally called the transition zone of the Wind River Formation by Van Houten (1964) and the upper transition zone of the Wind River Formation by the present author. Poor exposures make it difficult to map the upper transition zone separately from the Puddle Springs Arkose Member.

Age and Correlation

The only diagnostic fossils found in the Wind River Formation in the area studied are leaves characteristic of Green River forms 60 feet below the top of the formation in the SW¼NE¼ sec. 27, T. 33 N., R. 89 W. (Van Houten, 1964, p. 32) and vertebrate fossil fragments of early Eocene age in sec. 11, T. 35 N., R. 91 W. (written commun. Apr. 26, 1956, from C. L. Gazin to H. D. Zeller). Van Houten regarded the entire Wind River Formation here as early Eocene because the same leaves are found in or below strata containing early Eocene vertebrate fossils in the northwestern part of the Wind River Basin. The present author believes that the boundary between the early and middle Eocene may be in or at the top of the upper transition zone and that the Puddle Springs Arkose Member is of early Eocene age.

From approximate correlations with fossiliferous beds elsewhere in the basin, the Puddle Springs Arkose Member is believed to be of Lost Cabin age (latest early Eocene). The break between this member and the underlying lower fine-grained member may be approximately correlative with that between the Lost Cabin and Lysite Members (Tourtelot, 1948, p. 114–119) about 30 miles due north in the basin.

The Puddle Springs Arkose Member is probably equivalent to the upper coarse-grained arkosic facies of Rich (1962, p. 493–496) east of the Rattlesnake Range, to coarse arkosic rocks in the Wind River Formation at Shirley Basin to the southeast (Harshman, 1961), and partly equivalent to the Battle Spring Formation (Pipiringos, 1955, p. 103; 1961, p. A34–A35) in the Great Divide Basin to the south. The upper part of the member and the upper transition zone are apparently equivalent to the lower part of the Cathedral Bluffs Tongue of the Wasatch Formation and to the upper part of the Tipton Tongue of the Green River Formation of the Great Divide Basin, according to the age interpretations of Pipiringos (1961, table 1).

BOIS BLANC FORMATION

By William A. Oliver, Jr.

Name and Description

The Bois Blanc Formation was named by Ehlers (1945, p. 34, 80–109) for rocks in the Mackinac Straits region, and usage of the name was extended into southwestern Ontario, Canada, by Sanford and Brady (1955, p. 6). In both Michigan and Ontario the name was used for cherty limestones underlying the Detroit River Group (Formation in Ontario) and disconformably overlying Oriskany or older rocks.

The Bois Blanc Formation is more than 100 feet thick near Woodstock, Ontario (Stumm and others, 1956, p. 4). Eastward, the formation thins to 24 feet at Hagarsville, Ontario, and to about 15 feet at Port Colborne, Ontario. At Buffalo, N.Y., and extending to the Genesee Valley, the Bois Blanc is thin and discontinuous. One remnant 30 miles east of the Genesee has been recognized, and the Schoharie Grit in eastern New York is of the same age. Deposition may have been continuous over the intervening area.

In western New York and adjacent Ontario the Bois Blanc Formation is a medium dark-gray fine-grained limestone. The thickness varies from a few inches to 4 feet, but the formation is discontinuous and is absent in many places. Where the Bois Blanc is present, its lithology is in strong contrast to the overlying coarse crinoidal Onondaga Limestone. In western New York the Bois Blanc unconformably overlies the Akron and Bertie Formations of Silurian age.

The presence of rocks of Schoharie age in western New York was recognized by Cooper and others (1942, p. 1774–1775). The Buffalo area Bois Blanc is the lower brachiopod unit of Stauffer (1915, p. 6) and Zone B or the *Amphigenia* zone of Oliver (1954, p. 626, 632; 1960).

Basal Sandstone

Stauffer (1913, p. 85) proposed the name Springvale Sandstone Member for the basal sandy beds of the "Onondaga" in Ontario, and Chadwick (1919, p. 42) extended the usage of this term to New York. The name has served to emphasize that the sands are not of Oriskany age, especially in areas where true Oriskany does occur. In its type area near Hagarsville, Ontario, 60 miles west of Buffalo, the Springvale is a massive sandstone at least 8 feet thick at the base of the Bois Blanc Formation. Farther east in Ontario and in western New York, where the Bois Blanc is thin and discontinuous, a thin bed of sand or scattered sand grains may occur at the base of the Bois Blanc or at the base of the overlying Onondaga Limestone. Locally, in central New York, a true sandstone of Onondaga age is known. Because of age differences and the presence of two sands, the use of the term Springvale in New York is misleading, and it is recommended that such usage be discontinued.

Age and Correlation

The Bois Blanc Formation in New York contains a variety of fossils numerically dominated by brachiopods and corals, respectively. The rugose corals are characteristic of the Bois Blanc and are very different from the rugose corals of the overlying Onondaga. These characteristic corals occur also in the Schoharie Grit of eastern New York, the Bois Blanc Formation of Ontario and Michigan, the lower 4 feet of the Jeffersonville Limestone at the Falls of the Ohio (Louisville, Ky.), and the upper few feet of the Wildcat Valley Sandstone in southwestern Virginia. In addition, some of the corals described by Cranswick and Fritz (1958) from the Upper Abitibi River Limestone in the Hudson Bay Lowlands of Ontario belong to the same fauna.

The Schoharie and Bois Blanc rugose corals are endemic to eastern North America and give little evidence of the age of the fauna, although they are very useful for correlating within their province.

The associated brachiopods are being studied by Drs. A. J. Boucot and J. G. Johnson, both at the California Institute of Technology, who consider the brachiopods to indicate an early Emsian (late Early Devonian) age (written commun., 1965).

Conodonts from the Bois Blanc near Buffalo and from the Schoharie Grit in eastern New York are being studied by Dr. Gilbert Klapper, Pan American Petroleum Corp. He considers a late Emsian age to be indicated (oral commun., 1965).

The Bois Blanc Formation and its correlatives are concluded to be of Emsian (late Early Devonian) age.

CLARENCE MEMBER OF THE ONONDAGA LIMESTONE

By William A. Oliver, Jr.

The Clarence Member of the Onondaga Limestone was named by Ozol[3] (1964) to replace the term "western (black chert) facies of the Nedrow Member" of Oliver (1954, p. 636–637; pl. 1). The type section is at the village of Clarence, Erie County, N.Y. (Clarence 7½-minute quadrangle).

In the type area the Clarence Member is 40–45 feet thick and is composed of sparsely fossiliferous fine-grained limestone and dark-gray chert. Dunn and Ozol (1962, p. 19) report a chert content of 45–75 percent; this compares with 5–20 percent for underlying and overlying members. The high chert content characterizes the Clarence and makes it easily recognizable in surface exposures and many drilling logs.

The Clarence Member in western New York occupies the same stratigraphic position as the Nedrow Member of the Onondaga Limestone in central and eastern New York. Both are underlain by the Edgecliff Member and overlain by the Moorehouse Member. In contrast to the Clarence, however, the Nedrow Member consists of argillaceous limestone with abundant brachiopods and platyceratid gastropods. The two units are distinct, and conciseness is best served

[3] Ozol, M. A., 1963, Alkali reactivity of cherts and stratigraphy and petrology of cherts and associated limestones of the Onondaga Formation of central and western New York: Rensselaer Polytech. Inst., Troy, N.Y., unpub. Ph. D. thesis, 258 p.

by their recognition as separate members within the Onondaga Limestone.

THREE MEMBERS OF THE UPPER CAMBRIAN NOPAH FORMATION IN THE SOUTHERN GREAT BASIN

By Robert L. Christiansen and Harley Barnes

Work done in cooperation with the U.S. Atomic Energy Commission

This paper extends the use of the name Nopah Formation to the Nevada Test Site in Nye County, Nev. (fig. 9), and briefly describes its three members and names one member of the formation found in the southern Great Basin region. The report is only a brief résumé to present the basis of our revised nomenclature of pertinent relations at the Nevada Test Site and in the Groom Range (fig. 9).

The Nopah Formation was named by Hazzard (1937, p. 320–322) for rocks in the Nopah Range, where it is underlain by the Bonanza King Formation (Palmer and Hazzard, 1956) and overlain by the Pogonip(?) Dolomite of Hazzard (1937, p. 322–324). The Nopah has since been recognized by other authors throughout a large region of southeastern California and southern Nevada (McAllister, 1952, p. 9–10; Cornwall and Kleinhampl, 1961; Burchfiel, 1964, p. 49). The corresponding strata at the Nevada Test Site, underlain by the Middle and Upper Cambrian Bonanza King Formation and overlain by the Lower and Middle Ordovician Pogonip Group, are likewise here assigned to the Nopah Formation. These strata previously have been referred to as the Dunderberg Shale and the Windfall Formation (Barnes and Palmer, 1961, p. C103; Barnes and Byers, 1961; Barnes, Christiansen, and Byers, 1962, p. D31), formations originally defined in the Eureka district of central Nevada (see Nolan and others, 1956, p. 18–23).

At the Nevada Test Site the Nopah Formation can be readily divided into three members: at the base the Dunderberg Shale Member, 225 feet of red to brown shale with minor very thin bedded limestone; in the middle the Halfpint Member, 715 feet of flaggy-splitting very thin bedded medium-gray limestone with partings of silty limestone or shale and common thin layers of chert; and at the top the Smoky Member, 1,070 feet of blocky- to massive-splitting light- to dark-gray dolomite and limestone with relatively rare chert. The basal contact of the formation is sharp, but contacts between the members and at the top of the formation are gradational over a few feet to as much as 50 feet. The basal shale was recognized as the Dunderberg Shale by Johnson and Hibbard (1957, p. 342–343), Barnes and Palmer (1961, p. C103), and Barnes, Christiansen, and Byers (1962, p. D31); this correlation is still accepted on both lithologic and faunal grounds, but the Dunderberg is changed in rank to a member in areas where the

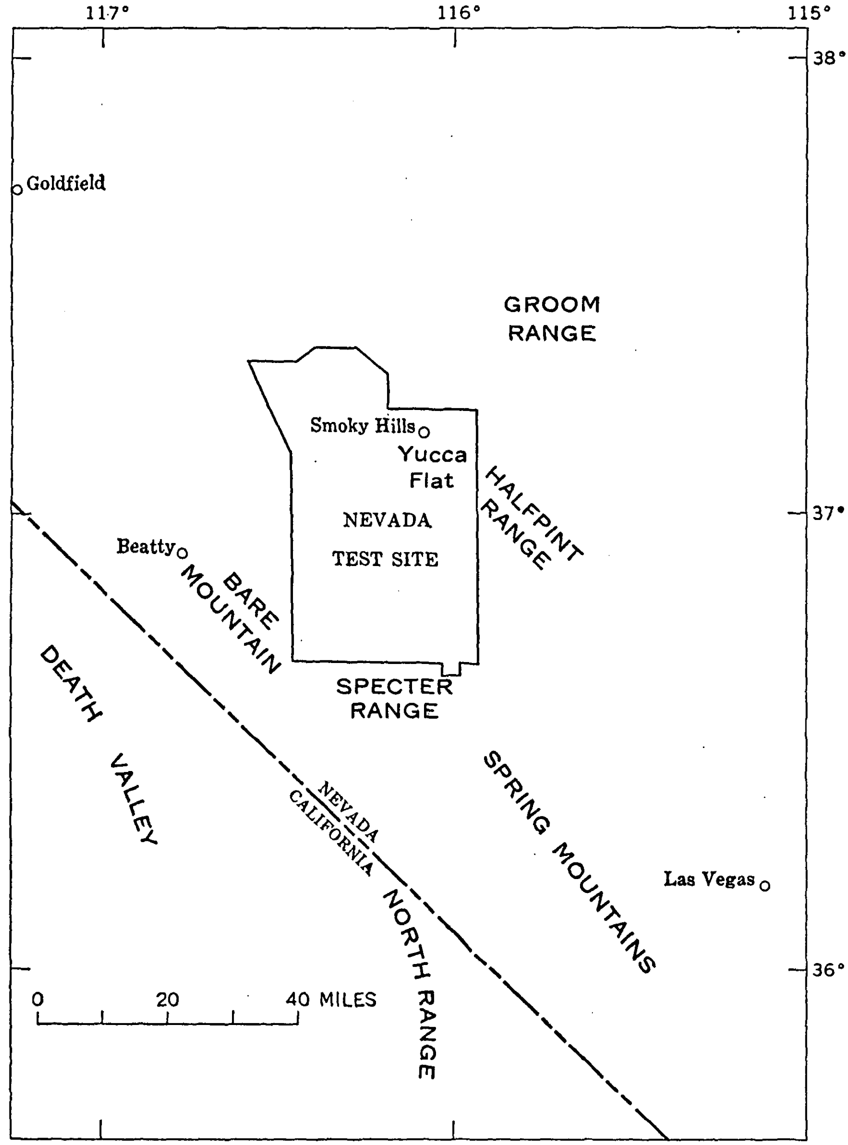

FIGURE 9.—Index map of part of southern Great Basin.

Nopah Formation is recognized. Barnes and Palmer (1961, p. C103) and Barnes and Byers (1961, p. C104) correlated the overlying rocks with the Windfall Formation because of the similarity of the flaggy-splitting silty and cherty limestone above the Dunderberg to the Windfall at Eureka. The flaggy-splitting limestone above the Dunderberg was assigned by them to the Catlin Member of the Windfall, which overlies the Dunderberg Shale at Eureka. This flaggy limestone is here named the Halfpint Member of the Nopah Formation; the section measured by Barnes and Byers on Teapot Ridge in the Halfpint Range, Nev., is here designated the type section. The next overlying unit at the Test Site is not represented in the section at Eureka and therefore was not assigned by Barnes and Palmer or Barnes and Byers to the upper member, the Bullwhacker, of the type Windfall. The upper member at the Test Site was recognized as a new unit, the Smoky Member of the Windfall Formation. This unit is here redesignated the Smoky Member of the Nopah Formation; its type locality is on Paiute Ridge in the Halfpint Range (Barnes and Byers, 1961, p. C105).

The Nopah Formation at the Nevada Test Site is directly correlative with the Nopah as generally mapped in areas farther southwest (McAllister, 1952; Cornwall and Kleinhampl, 1961; Yochelson and others, 1965, p. B75). It is worthy of note, however, that the top of the Nopah Formation as generally mapped in the region varies slightly from the type description of the Nopah. Hazzard (1937, p. 276) tentatively placed the top of the Nopah at the base of a "sandy and clayey, locally cross-bedded dolomite" (unit 9A) that he referred to as the basal "Pogonip(?) dolomite." Subsequent detailed mapping and regional work by McAllister (1952, p. 10–11), R. J. Ross (written commun., 1965), and by us, has shown that this sandy and clayey dolomite is correlative with a widespread silty unit in the Goodwin Limestone, some distance above the base of the Pogonip Group. Regionally, the base of the Pogonip lies at a change from massive-weathering relatively chert-free beds in the Smoky Member of the Nopah Formation to thin-bedded partly silty beds with abundant chert in the basal part of the Goodwin Limestone. There is generally also a change in weathered color from medium gray below to a lighter and more yellowish gray above this contact. Rocks above and below the contact may be either limestone or dolomite. Remeasurement of the type section of the Nopah shows that the base of the Pogonip, as recognized regionally, is about 500 feet lower than the tentative boundary of Hazzard; the Nopah Formation in the Nopah Range is about 1,270 feet thick rather than 1,740 feet.

All three members recognized at the Nevada Test Site are present in the type Nopah Formation. The Smoky Member which is not present in the Eureka district, is the dominant lithology of the Nopah Formation in the Nopah Range. The Halfpint and Dunderberg are thinner in the type Nopah, but both are represented in Hazzard's (1937, p. 276) unit 8A at the base of the formation, noted by him as being 100 feet thick. Unit 8A, as pointed out by Hazzard (1937, p. 320) is better exposed on the next ridge north than in the type section. At that place we have measured its total thickness as 135 feet instead of 100 feet, the Dunderberg Shale Member making up the basal 40 feet and the Halfpint Member the upper 95 feet of Hazzard's unit 8A.

Recent studies of Great Basin Cambrian sections by several workers have shown that the Dunderberg Shale is present throughout the region from the Eureka district to the southern Great Basin. We have traced the flaggy-splitting silty and cherty Halfpint Member of the Nopah Formation from the Groom district and the Nevada Test Site to the Nopah Range, although this member and the Dunderberg both thin notably southward. The stratigraphic continuity of this silty and cherty very thin bedded limestone between the Test Site and Eureka has not yet been demonstrated, but the Halfpint resembles the lithology of the Windfall Formation at Eureka. The massively outcropping Smoky Member of the Nopah thickens southward from the Groom district and the Test Site to compose most of the section in the Nopah Range, but it is not present at Eureka. Thus, all three lithologic units are common to the Test Site region and the Nopah Range but not to the Eureka district, and use of the name Windfall Formation is inappropriate at the Nevada Test Site.

We will discuss more fully the relations upon which these changes in nomenclature are based, along with more complete lithologic descriptions of the three members of the Nopah Formation, in a paper now in preparation on the Cambrian stratigraphy of the Groom district and its relation to sections at the Nevada Test Site and elsewhere in the southern Great Basin.

MEDUXNEKEAG GROUP AND SPRAGUEVILLE FORMATION OF AROOSTOOK COUNTY, NORTHEAST MAINE

By Louis Pavlides

This report revises the nomenclature and stratigraphic rank of several Ordovician and Silurian units in Aroostook County, Maine. The type localities used for naming the new formations described in this report are indicated on figure 10. These formations are only briefly described below.

MEDUXNEKEAG GROUP

The Meduxnekeag Formation, herein elevated to the Meduxnekeag Group, was originally named and defined by Pavlides (1962, p. 9–12 and pl. 1) and later more extensively described in the report on the Bridgewater quadrangle, Maine (Pavlides, 1965). This latter report should be consulted for the details of lithology of the various formations of the Meduxnekeag Group briefly described below. The Meduxnekeag Group of Ordovician and Silurian age, consists in ascending order, of the Chandler Ridge, Carys Mills, and Burnt

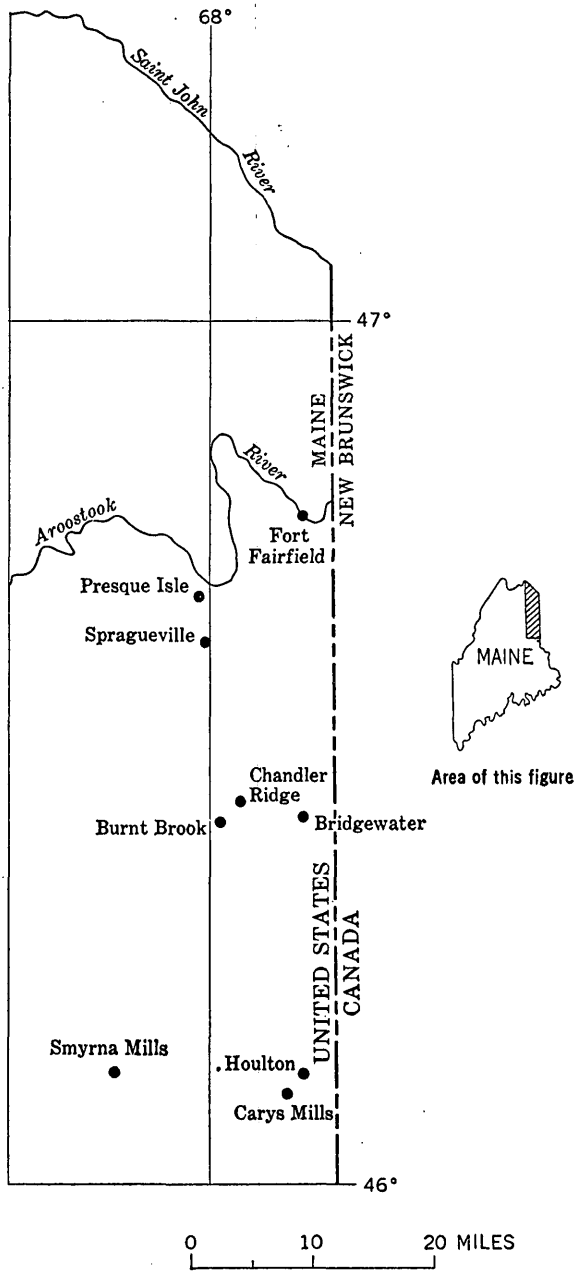

FIGURE 10.—Index map of part of Maine showing type localities of new formations described in this report.

Brook Formations. Table 1 shows the equivalence of the informally named members of the Meduxnekeag Formation to the formations of the Meduxnekeag Group, and the changes in age assignments among these units.

TABLE 1.—*Comparison of the Meduxnekeag Formation of former usage with the Meduxnekeag Group*

Pavlides (1962 and 1965)			Pavlides (this report)		
ORDOVICIAN	Meduxnekeag Formation	Slate member	SILURIAN(?)	Meduxnekeag Group	Burnt Brook Formation
		Ribbon rock member	ORDOVICIAN AND SILURIAN		Carys Mills Formation
		Slate and graywacke member	ORDOVICIAN(?)		Chandler Ridge Formation

CHANDLER RIDGE FORMATION

The slate and graywacke member of the Meduxnekeag Formation of former usage is here named the Chandler Ridge Formation after Chandler Ridge (fig. 10), its type locality, on which the formation is best exposed. The Chandler Ridge is a lenticular deposit of local extent consisting of slate, graywacke, and conglomeratic graywacke and minor amounts of siltstone and quartzite; it is estimated to have a maximum thickness of about 5,000 feet. Its lower contact is not exposed. The Chandler Ridge is apparently conformably overlain by a thinned sequence of the Ordovician and Silurian Carys Mills Formation (described below). Because the Carys Mills in the vicinity of Chandler Ridge is thin and its precise age in this area is not known, the underlying Chandler Ridge Formation is provisionally considered to be of Ordovician(?) age.

CARYS MILLS FORMATION

The Carys Mills Formation is herein named after the community of Carys Mills (fig. 10) where rocks typical of this formation are well exposed. The lithology of the Carys Mills is more fully described elsewhere as the ribbon rock member of the Meduxnekeag Formation (Pavlides, 1965). Typically, it consists of gray-blue limestone and calcareous siltstone interbedded with buff-weathered ankeritic limestone and with gray and green slate. Slate and slate and graywacke lenses are present at different stratigraphic levels within the Carys Mills in the Bridgewater quadrangle, where the formation is estimated to be as much as 12,000 feet thick and locally overlies the Chandler Ridge Formation. The Carys Mills conformably underlies and grades into the Smyrna Mills Formation of Silurian age in the Houlton and Smyrna Mills quadrangles (Pavlides and Berry, 1966). Until recently, the rocks now assigned to the Carys Mills were believed to be of Middle and Late(?) Ordovician age, but new paleontologic information from the Smyrna Mills quadrangle indicates the Carys Mills ranges into the Lower Silurian (Pavlides and Berry, 1966). The Carys Mills is now dated as Middle Ordovician (Caradoc) to Early Silurian (A_4–B_1 of the Llandovery) in age.

BURNT BROOK FORMATION

The Burnt Brook Formation, formerly the slate member of the Meduxnekeag Formation, is chiefly composed of green noncalcareous slate and gray calcareous slate. At a few places it has sparse thin gray-blue limestone interbeds. It conformably overlies the Carys Mills Formation, but is not overlain by younger rocks in its type area along Burnt Brook (fig. 10). It is at least 5,000 feet thick and is believed to be of Silurian(?) age, as it conformably overlies the Carys Mills Formation. It may be partly equivalent to the lower part of the Smyrna Mills Formation of Silurian age as well as to part of the lower member of the Perham Formation (table 2).

SPRAGUEVILLE FORMATION

This formation is here named after the community of Spragueville (fig. 10), the type locality, near which rocks of this unit are exposed. The Spragueville as herein defined is synonymous with the nubbly limestone member of the Aroostook Limestone as used by White (1943), which Boucot and others (1964, p. 26–29) describe as an "Unnamed Silurian limestone."

The name Aroostook Limestone, in the usage of White (1943), herein is abandoned as a stratigraphic name because the superpositional order of one of its three members is inverted, and this inverted member (White's lower member) has since been assigned to the overlying Perham Formation (Boucot and others, 1964, p. 35). Table 2 summarizes the revisions of stratigraphy, chronology, and nomenclature in the Aroostook Limestone of White's usage by Boucot and others (1964) and in this report. The middle or ribbon limestone member of the Aroostook Limestone of White's usage is actually coextensive with the Carys Mills Formation and is so named and assigned herein. Earlier, the ribbon limestone member of the Aroostook Limestone was considered equivalent to the ribbon rock member of the Meduxnekeag Formation (Pavlides, 1962, p. 23), and this usage was followed by Boucot and others (1964) in the Presque Isle region. A synonymy is achieved therefore by assigning the ribbon rock member of the Meduxnekeag Formation and the ribbon limestone member of the Aroostook Limestone to the Carys Mills Formation.

In summary, rock units previously assigned to the Aroostook Limestone are now assigned, in ascending order, to the Carys Mills Formation, the Spragueville Formation, and the lower member of the Perham Formation.

TABLE 2.—*Summary of revisions of superposition, chronology, and nomenclature in the Aroostook Limestone in northern Maine*

White (1943)				Boucot and others (1964)		Pavlides (this report)	
SILURIAN		Shale and slate unit (lower member)	Boucot and others (1964) →	SILURIAN	Perham Formation (lower member)	SILURIAN	Perham Formation (lower member)
SILURIAN	Aroostook Limestone	Upper member, nubbly limestone		SILURIAN	Unnamed limestone	SILURIAN	Spragueville Formation
SILURIAN	Aroostook Limestone	Middle member ribbon limestone		ORDOVICIAN	Meduxnekeag Formation (ribbon rock member)	ORDOVICIAN and SILURIAN	Carys Mills Formation
SILURIAN	Aroostook Limestone	Lower member slate and calcareous slate	Boucot and others (1964)				

The Spragueville Formation consists chiefly of gray to pale olive-green calcareous siltstone and silty limestone and was estimated by Boucot and others to be about 4,000 feet thick. It was assigned a late Llandoverian (C_3–C_5), Early Silurian age. Mapping in progress by the writer has revised the distribution pattern of the Spragueville from that originally shown by Boucot and others (1964, pl. 1) and may necessitate a revision of its thickness when mapping has been completed in this region. The Spragueville conformably overlies the Carys Mills gradationally and conformably underlies the Perham Formation in the Presque Isle region. The Spragueville is now also known to crop out in the Fort Fairfield area of northern Maine (Louis Pavlides, Ely Mencher,[4] and David C. Roy,[4] unpub.), but there it is not overlain by younger rocks. Graptolites from the Spragueville Formation north of Fort Fairfield have been dated as Silurian and belonging to British graptolite zone 19 (W. B. N. Berry, written commun., 1965). Thus, the Early Silurian age span of the Spragueville is from Lower to Upper (C_3–C_5) Llandovery. The Spragueville is in part the temporal equivalent of the Frenchville Formation (Pavlides and others, 1964, p. C32) and, in part, of the lower member of the Perham Formation (Louis Pavlides, unpub. data). Both the Carys Mills and Spragueville Formations contain Silurian graptolites of zone 19, so that they are also in part coeval and may locally intertongue.

REFERENCES CITED

Agar, W. M., 1932, The petrology and structure of the Salisbury-Canaan district of Connecticut: Am. Jour. Sci., 5th ser., v. 23, p. 31–48.

Barnes, Harley, and Byers, F. M., Jr., 1961, Windfall Formation (Upper Cambrian) of Nevada Test Site and vicinity, Nevada *in* Short papers in the geologic and hydrologic sciences: U.S. Geol. Survey Prof. Paper 424–C, p. C103–C106.

Barnes, Harley, Christiansen, R. L., and Byers, F. M., Jr., 1962, Cambrian Carrara Formation, Bonanza King Formation, and Dunderberg Shale east of Yucca Flat, Nye County, Nevada, *in* Short papers in geology, hydrology, and topography: U.S. Geol. Survey Prof. Paper 450–D, p. D27–D31.

——— 1965, Geologic map of Jangle Ridge quadrangle, Nye and Lincoln Counties, Nevada: U.S. Geol. Survey Geol. Quad. Map GQ–363, scale 1 : 24,000.

Barnes, Harley, and Palmer, A. R., 1961, Revision of stratigraphic nomenclature of Cambrian rocks, Nevada Test Site and vicinity, Nevada, *in* Short papers in the geologic and hydrologic sciences: U.S. Geol. Survey Prof. Paper 424–C, p. C100–C103.

Boucot, A. J., Field, M. T., Fletcher, Raymond, Forbes, W. H., Naylor, R. S., and Pavlides, Louis, 1964, Reconnaissance bedrock geology of the Presque Isle quadrangle, Maine: Maine Geol. Survey Quad. Mapping Ser., no. 2, 123 p.

Bowyer, Ben, Pampeyan, E. H., and Longwell, C. R., 1958, Geologic map of Clark County, Nevada: U.S. Geol. Survey Mineral Inv. Field Studies Map MF–138, scale 1 : 200,000.

Brown, C. E., and Thayer, T. P., 1963, Low-grade mineral facies in Upper Triassic and Lower Jurassic rocks of the Aldrich Mountains, Oregon: Jour. Sed. Petrology, v. 33, no 2, p. 411–425.

——— 1966a, Geologic map of the Canyon City quadrangle, Oregon: U.S. Geol. Survey Misc. Geol. Inv. Map I–447.

——— 1966b, Geologic map of the Mount Vernon quadrangle, Grant County, Oregon: U.S. Geol. Survey Geol. Quad. Map GQ–548 (in press).

Burchfiel, B. C., 1964, Precambrian and Paleozoic stratigraphy of Specter Range quadrangle, Nye County, Nevada: Am. Assoc. Petroleum Geologists Bull., v. 48, no. 1, p. 40–56.

[4] Massachusetts Institute of Technology, Cambridge, Mass.

Cady, W. M., 1956, Bedrock geology of the Montpelier quadrangle, Vermont: U.S. Geol. Survey Geol. Quad. Map GQ–79.

Chadwick, G. H., 1919, Phelps quadrangle: New York State Mus. Bull. 207–208, p. 42–43.

Cooper, G. A., and others, 1942, Correlation of the Devonian sedimentary formations of North America: Geol. Soc. America Bull., v. 53, p. 1729–1794.

Cornwall, H. R., and Kleinhampl, F. J., 1961, Geology of the Bare Mountain quadrangle, Nevada: U.S. Geol. Survey Geol. Quad. Map GQ–157.

Cranswick, J. S., and Fritz, M. A., 1958, Coral fauna of the Upper Abitibi River Limestone: Geol. Assoc. Canada Proc., v. 10, p. 31–81.

Dale, T. N., 1891, The Greylock synclinorium: Am. Geologist, v. 8, p. 1–7.

——— 1923, The lime belt of Massachusetts and parts of eastern New York and western Connecticut: U.S. Geol. Survey Bull. 744, 71 p.

Doll, C. G., Cady, W. M., Thompson, J. B., Jr., and Billings, M. P., 1961, Centennial geologic map of Vermont: Montpelier, Vt., Vermont Geol. Survey, scale 1:250,000.

Dunn, J. R., and Ozol, M. A., 1962, Deleterious properties of chert: New York Dept. Public Works, Eng. Research Ser., RR, 62–7, 78 p.

Ehlers, G. M., 1945, Stratigraphy of the surface formations of the Mackinac Straits region: Michigan Geol. Survey Div., Pub. 44, Geol. Ser. 37, p. 19–120.

Emerson, B. K., 1898, Geology of old Hampshire County, Massachusetts, comprising Franklin, Hampshire, and Hampden Counties: U.S. Geol. Survey Mon. 29, 790 p.

——— 1917, Geology of Massachusetts and Rhode Island: U.S. Geol. Survey Bull. 597, 289 p.

Emmons, Ebenezer, 1842, Geology of New York, Part II, comprising the survey of the second geological district: Albany, N.Y., 437 p.

Gregory, H. E., and Robinson, H. H., 1907, Preliminary geological map of Connecticut: Connecticut Geol. Survey Bull. 7, 39 p.

Harshman, E. N., 1961, Paleotopographic control of a uranium mineral belt, Shirley Basin, Wyoming *in* Short papers in the geologic and hydrologic sciences: U.S. Geol. Survey Prof. Paper 424–C, p. C4–C5.

Hazzard, J. C., 1937, Paleozoic section in the Nopah and Resting Springs Mountains, Inyo County, California: California Jour. Mines and Geology, v. 33, no. 4, p. 273–339.

Herz, Norman, 1961, Bedrock geology of the North Adams quadrangle, Massachusetts-Vermont: U.S. Geol. Survey Geol. Quad. Map GQ–139.

Hobbs, W. H., 1893, On the geological structure of the Mount Washington mass of the Taconic Range [Mass.]: Jour. Geology, v. 1, p. 717–736.

——— 1897, Note on the geology of southwestern New England: Jour. Geology, v. 5, p. 175–177.

Johnson, M. S., and Hibbard, D. E., 1957, Geology of the Atomic Energy Commission Nevada proving grounds area, Nevada: U.S. Geol. Survey Bull. 1021–K, p. 333–384.

McAllister, J. F., 1952, Rocks and structure of the Quartz Spring area, northern Panamint Range, California: California Div. Mines Spec. Rept. 25, 38 p.

Merriam, J. C., Stock, Chester, and Moody, C. L., 1925, The Pliocene Rattlesnake Formation and fauna of eastern Oregon, with notes on the geology of the Rattlesnake and Mascall deposits: Carnegie Inst. Washington Pub. 347, p. 43–92.

New York State Museum and Science Service, Geological Survey, 1962, Geologic map of New York, 1961: New York State Mus. and Sci. Service, Geol. Survey, Map and Chart Ser. no. 5, 5 sheets, scale 1:250,000, text.

Nolan, T. B., 1929, Notes on the stratigraphy and structure of the northwest portion of Spring Mountain, Nevada: Am. Jour. Sci., 5th ser., v. 17, p. 461–472.

Nolan, T. B., Merriam, C. W., and Williams, J. S., 1956, The stratigraphic section in the vicinity of Eureka, Nevada: U.S. Geol. Survey Prof. Paper 276, 77 p.

Oliver, W. A., Jr., 1954, Stratigraphy of the Onondaga Limestone (Devonian) in central New York: Geol. Soc. America Bull., v. 65, p. 621–652.

——— 1960, Coral faunas in the Onondaga Limestone of New York *in* Short papers in the geological sciences: U.S. Geol. Survey Prof. Paper 400–B, p. 172–174.

Ozol, M. A., 1964, Alkali reactivity of cherts and stratigraphy and petrology of cherts and associated limestones of the Onondaga Formation of central and western New York: Dissert. Abs., v. 24, no. 10, p. 4144–4145.

Palmer, A. R., and Hazzard, J. C., 1956, Age and correlation of Cornfield Springs and Bonanza King Formation in southeastern California and southern Nevada: Am. Assoc. Petroleum Geologists Bull., v. 40, no. 10, p. 2494–2499.

Pavlides, Louis, 1962, Geology and manganese deposits of the Maple and Hovey Mountains area, Aroostook County, Maine: U.S. Geol. Survey Prof. Paper 362, 116 p.

——— 1965, Geology of the Bridgewater quadrangle, Aroostook County, Maine: U.S. Geol. Survey Bull. 1206, 72 p.

Pavlides, Louis, and Berry, W. B. N., 1966, Graptolite-bearing Silurian rocks of the Houlton-Smyrna Mills area, Aroostook County, Maine: U.S. Geol. Survey Prof. Paper 550–B, p. B 51–B61.

Pavlides, Louis, Mencher, Ely, Naylor, R. G., and Boucot, A. J., 1964, Outline of the stratigraphic and tectonic features of northern Maine: U.S. Geol. Survey Prof. Paper 501–C, p. C28–C38.

Pipiringos, G. N., 1955, Tertiary rocks in the central part of the Great Divide Basin, Sweetwater County, Wyoming, *in* Wyoming Geol. Assoc. Guidebook 10th Ann. Field Conf. 1955: p. 100–104.

——— 1961, Uranium-bearing coal in the central part of the Great Divide Basin [Wyoming]: U.S. Geol. Survey Bull. 1099–A, p. A1–A104.

Potter, D. B., 1963, Stratigraphy and structure of the Hoosick Falls area, *in* Bird, J. M., ed., Stratigraphy, structure, sedimentation, and paleontology of the southern Taconic region, eastern New York: Geol. Soc. America, Ann. Mtg., New York City, Nov. 16–17, 1963, Guidebook Field Trip 3, p. 58–67.

Prindle, L. M., and Knopf, E. B., 1932, Geology of the Taconic quadrangle: Am Jour. Sci., 5th ser., v. 24, p. 257–302.

Pumpelly, Raphael, Wolff, J. E., and Dale, T. N., 1894, Geology of the Green Mountains in Massachusetts: U.S. Geol. Survey Mon. 23, 206 p.

Rich, E. I., 1962, Reconnaissance geology of Hiland-Clarkson Hill area, Natrona County, Wyoming: U.S. Geol. Survey Bull. 1107–G p. 447–540.

Rodgers, John, Gates, R. M., and Rosenfeld, J. L., 1959, Explanatory text for preliminary geological map of Connecticut, 1956: Connecticut Geol. and Nat. History Survey Bull. 84, 64 p.

Sanford, B. V., and Brady, W. B., 1955, Palaeozoic geology of the Windsor-Sarnia area, Ontario: Canada Geol. Survey Mem. 278, 65 p.

Soister, P. E., 1958, Preliminary stratigraphy of Wind River Formation in Gas Hills area [Wyoming]: U.S. Geol. Survey Rept. TEI–740, p. 112–120.

Stauffer, C. R., 1913, Geology of the region around Hagarsville [Ontario]: Internat. Geol. Cong., 12th, Toronto 1913, Guidebook 4, p. 82–99.

——— 1915, The Devonian of southwestern Ontario: Canada Geol. Survey Mem. 34, 341 p.

Stewart, J. H., 1966, Correlation of Lower Cambrian and some Precambrian strata in the southern Great Basin: U.S. Geol. Survey Prof. Paper 550–C, p. C66–C 72.

Stumm, E. C., and others, 1956, Devonian strata of the London-Sarnia area, southwestern Ontario, Canada [guidebook], annual field trip, June 9–10, 1956: Michigan Geol. Soc., 21 p.

Thayer, T. P., 1957, Some relations of later Tertiary volcanology and structure in eastern Oregon, *in* Tomo 1 of Vulcanología del Cenozoico: Internat. Geol. Cong., 20th, México, D.F., 1956 [Trabajos], sec. 1, p. 231–245.

Thayer, T. P., and Brown, C. E., 1966, Geologic map of the Aldrich Mountain quadrangle, Grant County, Oregon: U.S. Geol. Survey Geol. Quad. Map GQ–438.

Tourtelot, H. A., 1948, Tertiary rocks in the northeastern part of the Wind River Basin, Wyoming, *in* Wyoming Geol. Assoc. Guidebook 3d Ann. Field Conf., Wind River Basin, 1948, p. 112–124.

Tschanz, C. M., and Pampeyan, E. H., 1961, Preliminary geologic map of Lincoln County, Nevada: U.S. Geol. Survey Mineral Inv. Field Studies Map MF–206, scale 1:200,000.

Van Houten, F. B., 1964, Tertiary geology of the Beaver Rim area, Fremont and Natrona Counties, Wyoming: U.S. Geol. Survey Bull. 1164, 99 p.

Waters, A. C., 1961, Stratigraphic and lithologic variations in the Columbia River Basalt: Am. Jour. Sci., v. 259, no. 8, p. 583–611.

Weaver, J. D., 1957, Stratigraphy and structure of the Copake quadrangle, New York: Geol. Soc. America Bull., v. 68, no. 6, p. 725–762.

White, W. S., 1943, Occurrence of manganese in eastern Aroostook County, Maine: U.S. Geol. Survey Bull. 940–E, p. 125–161.

Wright, L. A., and Troxel, B. W., 1966, Strata of late Precambrian-Cambrian age, Death Valley region, California-Nevada: Am. Assoc. Petroleum Geologists, v. 50, no. 5, p. 846–857.

Yochelson, E. L., McAllister, J. F., and Reso, Anthony, 1965, Stratigraphic distribution of the Late Cambrian mollusk *Matthevia* Walcott, 1885, *in* Geological Survey Research 1965: U.S. Geol. Survey Prof. Paper 525–B, p. B73–B78.

Zeller, H. D., Soister, P. E., and Hyden, H. J., 1956, Preliminary geologic map of the Gas Hills uranium district, Fremont and Natrona Counties, Wyoming: U.S. Geol. Survey Mineral Inv. Field Studies Map MF–83.

Zen, E-an, 1964a, Taconic stratigraphic names: Definitions and synonymies: U.S. Geol. Survey Bull. 1174, 95 p.

——— 1964b, Subdivision of the Stockbridge Limestone in southwestern Massachusetts and adjacent Connecticut [abs.]: Geol. Soc. America Spec. Paper 76, p. 183–184.

Zen, E-an, and Hartshorn, J. H., 1966, Geology of the Bashbish Falls quadrangle, Berkshire County, Massachusetts, Litchfield County, Connecticut, and Dutchess and Columbia Counties, New York: U.S. Geol. Survey Geol. Quad. Map GQ–507.

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