Changes in Stratigraphic Nomenclature by the U.S. Geological Survey 1967

GEOLOGICAL SURVEY BULLETIN 1274-A

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CONTRIBUTIONS TO STRATIGRAPHY

GEOLOGICAL SURVEY BULLETIN 1274-A

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1969

UNITED STATES DEPARTMENT OF THE INTERIOR

WALTER J. HICKEL, *Secretary*

GEOLOGICAL SURVEY

William T. Pecora, *Director*

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price 40 cents (paper cover)

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By George V. Cohee, Robert G. Bates, and Wilna B. Wright

LISTINGS OF NOMENCLATURAL CHANGES

In the following table, stratigraphic names adopted, revised, reinstated, or abandoned are listed alphabetically. The age of the unit, the revision, the area involved, the author's name, and date of publication of the report are given. The publications in which the changes in nomenclature were made are listed in the references at the end of this publication. The capitalization of age terms in the age column follows official usage.

CHANGES IN STRATIGRAPHIC NOMENCLATURE

Name	Age	Location	Revision and reference
Abrigo Formation	Middle and Late Cambrian	southeastern Arizona	Abrigo Formation in report area subdivided (in ascending order) into the Three C, Southern Belle, and Peppersauce Members. (Creasey, 1967b.)
Achiote Conglomerate	Late Cretaceous	west-central Puerto Rico	New name adopted. (Mattson, 1967.)
Adams Argillite	Early Cambrian	east-central Alaska	New name adopted. (Brabb, 1967.)
Admire Group	Early Permian	northeastern Kansas	Age changed from Permian to Early Permian. (Johnson and Wagner, 1967.)
Alaska Bench Limestone (of Amsden Group)	Early and Middle Pennsylvanian.	western Montana	Alaska Bench Limestone removed from Big Snowy Group and reassigned as middle formation of Amsden Group. Age changed from Mississippian or Pennsylvanian to Early and Middle Pennsylvanian. (Maughan and Roberts, 1967.)
Aleman Formation (of Montoya Group)	Late Ordovician	southwestern New Mexico	Formerly Aleman Cherty Member of Montoya Dolomite and remains a member of this formation outside the report area. (Pratt, 1967.)
Allsbury Formation	Early Silurian	northeastern Maine	New name adopted. (Ekren and Frischknecht, 1967.)
Alta Formation	Early Permian (Wolfcamp)	west Texas	Age changed from Permian to Early Permian. (Oriel, Myers, and Crosby, 1967.)
American Flag Formation	Cretaceous(?)	south-central Arizona	New name adopted. (Creasey, 1967b.)
Americus Limestone Member (of Foraker Limestone).	Early Permian	northeastern Kansas	Age changed from Permian to Early Permian. (Johnson and Wagner, 1967.)
Amsden Group	Early and Middle Pennsylvanian.	central Montana	Amsden raised to group rank in central Montana where it includes (in ascending order) the Tyler Formation, Alaska Bench Limestone, and Devils Pocket Formation. Amsden Formation remains in good usage elsewhere. (Maughan and Roberts, 1967.)
Andrecito Member (of Lake Valley Limestone)	Early Mississippian (Osage)	southwestern New Mexico	Andrecito Member of Laudon and Bowsher (1949) adopted. (Jones, Hernon, and Moore, 1967.)
Anón Formation	middle to late Eocene	west-central Puerto Rico	Anón Formation of Pessagno (1960) adopted. (Mattson, 1967.)
Antelope Valley Formation (of Pogonip Group)	Early and Middle Ordovician	southeastern California	Formation in part of Inyo County, Calif. Remains Antelope Valley Limestone in Nevada. (Ross, 1967.)

Arcturus Formation	Early Permian	Nevada	Age changed form Permian to Early Permian. (Ketner, 1967.)
Ashlock Formation	Late Ordovician (Cincinnatian).	central Kentucky	In central Kentucky, from Richmond north to Owingsville, the Gilbert and Stingy Creek Members of the Ashlock Formation are replaced by the Grant Lake Member. (Simmons, 1967b.)
Aspinwall Limestone Member (of Onaga Shale)	Early Permian	northeastern Kansas	Age changed from Permian to Early Permian. (Johnson and Wagner, 1967.)
Austin Glen Member (of Normanskill Shale)	Middle Ordovician	eastern New York	Austin Glen Member of Ruedemann (1942) adopted. (Zen, 1967.)
Avoca Limestone Member (of Lecompton Limestone)	Late Pennsylvanian (Virgil)	northeastern Kansas	Avoca Limestone Member of Condra (1927) adopted. (Johnson and Adkison, 1967.)
Bakken Formation	Late Devonian and Early Mississippian.	Montana and North Dakota	Age changed from Late Devonian(?) and Early Mississippian to Late Devonian and Early Mississippian. (Sandberg and Klapper, 1967.)
Banjo Point Formation	Oligocene(?)	Alaska	Age changed from Oligocene or Miocene to Oligocene(?). (MacNeil, 1967.)
Bauers Tuff Member (of Quichapa Formation)	Oligocene or Miocene	southwestern Utah	Bauers Tuff Member of Mackin (1960) adopted. (Averitt, 1967.)
Bay of Pillars Formation	Late Silurian	southeastern Alaska	New name adopted. (Muffler, 1967.)
Bean Canyon Formation	late Paleozoic(?)	southeastern California	Age changed from Paleozoic(?) to late Paleozoic(?). (Dibblee, 1967a.)
Bedrock Spring Formation	middle(?) Pliocene	do	Age changed from middle Pliocene to middle(?) Pliocene. (Dibblee, 1967a.)
Beebe Limestone Member (of West Castleton Formation).	Early Cambrian	western Vermont	Reduced in rank from Beebe Limestone to Beebe Limestone Member. (Zen, 1967.)
Beil Limestone Member (of Lecompton Limestone).	Late Pennsylvanian (Virgil)	northeastern Kansas	Beil Limestone Member of Condra (1930) adopted. (Johnson and Adkison, 1967.)
Big Hole Basalt	Pleistocene	southeastern Idaho	Included in Snake River Group. (Mundorff, 1967.)
Big Snowy Group	Late Mississippian	Montana and North Dakota	Big Snowy Group restricted to (in ascending order) the Kibbey Sandstone, Otter and Heath Formations, of Late Mississippian (Chester) age. (Maughan and Roberts, 1967).
Big Springs Limestone Member (of Lecompton Limestone).	Late Pennsylvanian (Virgil)	northeastern Kansas	Big Springs Limestone Member of Condra (1927) adopted. (Johnson and Adkison, 1967.)
Bissell Formation (of Tropico Group)	Miocene(?)	southeastern California	Age changed from Miocene or Pliocene to Miocene(?) (Dibblee, 1967a.)
Black Mountain Basalt	Pleistocene	do	Black Mountain Basalt of Baker (1912) adopted. (Dibblee, 1967a.)

CHANGES IN STRATIGRAPHIC NOMENCLATURE—Continued

Name	Age	Location	Revision and reference
Bomoseen Graywacke Member (of Bull Formation).	Cambrian(?)	western Vermont	Bomoseen Graywacke Member of Ruedemann (1914) adopted. (Zen, 1967.)
Bossardville Limestone	Late Silurian	Pennsylvania, New Jersey and New York.	Age changed from Silurian to Late Silurian (Cayuga). (Epstein, Epstein, Spink, and Jennings, 1967.)
Boundary Ridge Member (of Twin Creek Limestone).	Middle(?) Jurassic	southeastern Idaho, northwestern Wyoming, and northern Utah.	New name adopted. (Imlay, 1967.)
Box Member (of Percha Shale)	Late Devonian	southwestern New Mexico	Box Member of Stevenson (1944) adopted. (Jones, Hernon, and Moore, 1967.)
Bozeman Group	Tertiary	southwestern Montana	Bozeman Group in report area divided into (ascending order) Climbing Arrow, Dunbar Creek, and Sixmile Creek Formations. (Robinson, 1967.)
Bull Formation	Cambrian(?) and Early Cambrian.	western Vermont	Formerly Bull Slate of Early Cambrian age. Includes (ascending order) Bomoseen Graywacke and Zion Hill Quartzite Members. (Zen, 1967.)
Burls Creek Shale Member (of Katalla Formation).	late(?) Oligocene	Alaska	Age changed from Oligocene to late(?) Oligocene. (MacNeil, 1967.)
Burnt Island Conglomerate (of Hyd Group)	Late Triassic	southeastern Alaska	New name adopted. (Muffler, 1967.)
Burroak Shale Member (of Deer Creek Limestone).	Late Pennsylvanian (Virgil)	northeastern Kansas	Burroak Shale Member of Condra and Reed (1937) adopted. (Johnson and Adkison, 1967.)
Bushkill Member (of Martinsburg Formation)	Middle and Late Ordovician	Pennsylvania and New Jersey	New name adopted. Basal member of Martinsburg Formation. (Drake and Epstein, 1967.)
Cable Canyon Sandstone Member (of Montoya Dolomite).	Middle Ordovician	southwestern New Mexico	Age changed from Late Ordovician to Middle Ordovician. (Jones, Hernon, and Moore, 1967.)
Cable Canyon Sandstone Member (of Second Value Dolomite).	do	do	Formerly Cable Canyon Sandstone Member of Montoya Dolomite, which remains good usage elsewhere. (Pratt, 1967.)
Cameron Creek Member (of Tyler Formation)	Early Pennsylvanian (Morrow).	western Montana	Reduced to member rank and made upper member of Tyler Formation. Age changed from Mississippian or Pennsylvanian to Early Pennsylvanian (Morrow). (Maughan and Roberts, 1967.)
Cape Thompson Member (of Nasorak Formation).	Early Mississippian	northwestern Alaska	New name adopted. (Campbell, 1967.)

Carlisle Center Formation	Early Devonian	east-central New York	Age changed from Early or Middle Devonian to Early Devonian. (Oliver, 1967.)
Carmel Formation	Middle and Late Jurassic	southwestern Utah	In report area divided into (ascending order) limestone member, banded member, gypsiferous member, and Winsor Member. (Cashion, 1967a.)
Carney Lake Gneiss	early Precambrian	Upper Peninsula, Michigan	Carney Lake Gneiss of Treves (1960) adopted. (Bayley, Dutton, and Lamey, 1966.)
Cenotaph Volcanics	post-early Oligocene(?) to pre-middle Miocene.	south-central Alaska	New name adopted. (Plafker, 1967.)
Chariot Gravel	Pleistocene	northwestern Alaska	New name adopted. (Campbell, 1967.)
Charles Formation (of Madison Group)	Late Mississippian (Meramec)	western Montana	Age changed from Early Mississippian to Late Mississippian. (Maughan and Roberts, 1967.)
Chicopee Shale	Late Triassic	southwestern Massachusetts	Name abandoned. (Hartshorn and Koteff, 1967.)
Chinitna Formation	Late Jurassic	southwestern Alaska	Chinitna Formation divided into (ascending order) Tonnie Siltstone and Paveloff Siltstone Members. (Detterman and Hartsock, 1966.)
Cibolo Formation	Early Permian (Wolfcamp and Leonard).	west Texas	Age changed from Permian to Early Permian (Wolfcamp and Leonard). (Oriel, Myers, and Crosby, 1967.)
Cieneguita Formation	Middle and Late Pennsylvanian.	west Texas	Age changed from Pennsylvanian and Permian to Middle and Late Pennsylvanian. (Oriel, Myers, and Crosby, 1967.)
Clay Creek Limestone Member (of Kanwaka Shale).	Late Pennsylvanian (Virgil)	northeastern Kansas	Clay Creek Limestone Member of Moore (1932) adopted. (Johnson and Adkison, 1967.)
Cloudburst Formation	Late(?) Cretaceous or early Tertiary.	south-central Arizona	Age changed from Late Cretaceous(?) and Tertiary to Late(?) Cretaceous or early Tertiary. (Creasey, 1967b.)
Clove Brook Member (of Decker Formation)	Late Silurian	New Jersey	New name adopted. (Epstein, Epstein, Spink, and Jennings, 1967.)
Coachella Fanglomerate	Miocene(?)	southeastern California	Coachella Fanglomerate of Vaughan (1922) adopted. (Dibblee, 1967b.)
Coeymans Formation (of Helderberg Group)	Early Devonian	New Jersey and Pennsylvania	In report area, name changed from Coeymans Limestone to Coeymans Formation; includes (ascending order) Depue Limestone, Peters Valley, Shawnee Island, and Stormville Members. Coeymans Limestone remains in good usage elsewhere. (Epstein, Epstein, Spink, and Jennings, 1967.)
Coeymans Limestone (of Helderberg Group)	Early Devonian	eastern New York	Ravena Member included. (Epstein, Epstein, Spink, and Jennings, 1967.)
Concha Limestone (of Naco Group)	Early Permian	Arizona	Age changed from Permian to Early Permian. (McKee, 1967.)

CHANGES IN STRATIGRAPHIC NOMENCLATURE—Continued

Name	Age	Location	Revision and reference
Corbin Sandstone Member (of Lee Formation)	Early Pennsylvanian	southeastern Kentucky	Corbin Sandstone Tongue adopted for Wofford, Hollyhill, and Williamsburg quadrangles. Corbin Sandstone Member remains in good usage elsewhere. (Smith, 1967.)
Cornwallis Limestone (of Hyd Group)	Late Triassic	southeastern Alaska	New name adopted. (Muffler, 1967.)
Cottonwood Canyon Member (of Madison Limestone).	Late Devonian and Early Mississippian.	northern and west-central Wyoming.	New name adopted. (Sandberg and Klapper, 1967.)
Cottonwood Canyon Member (of Lodgepole Limestone of Madison Group).	Early Mississippian	southern Montana	New name adopted. (Sandberg and Klapper, 1967.)
Council Grove Group	Early Permian	northeastern Kansas	Age changed from Permian to Early Permian. (Johnson and Wagner, 1967.)
Coyote Butte Formation	Early Permian (Wolfcamp and Leonard).	Oregon	Age changed from Permian to Early Permian (Wolfcamp and Leonard). (Ketner, 1967.)
Crab Orchard Formation	Early and Middle Silurian	central Kentucky	Crab Orchard Formation of report area includes (ascending order) Lower Silurian Plum Creek Member, and Middle Silurian Oldham, Lulbegrud Shale, Waco, and Estill Shale Members. (Simmons, 1967a.)
Crowder Formation	Pliocene	southeastern California	New name adopted. (Dibblee, 1967a.)
Cuba Mesa Member (of San Jose Formation)	early Eocene	northwestern New Mexico	New name adopted. (Baltz, 1967.)
Curzon Limestone Member (of Topeka Limestone).	Late Pennsylvanian (Virgil)	northeastern Kansas	Curzon Limestone Member of Gallaher (1898) adopted. (Johnson and Adkison, 1967.)
Cutter Dolomite (of Montoya Group)	Late Ordovician	southwestern New Mexico	Cutter Dolomite used in report area. Cutter Dolomite Member or Cutter Member in good usage elsewhere. (Pratt, 1967.)
Danby Formation	Late(?) Cambrian	western Vermont	Age changed from Early Cambrian to Late(?) Cambrian. (Zen, 1967.)
Daylight Formation	Precambrian and Early Cambrian.	southern California and southern Nevada.	Age changed from Early Cambrian to Precambrian and Early Cambrian. (Barnes and Christiansen, 1967.)
De Chelly Sandstone	Early Permian (Leonard)	Colorado, Arizona, and New Mexico.	Age changed from Permian to Early Permian (Leonard). (Hallgarth, 1967.)
Decker Formation	Late Silurian	New Jersey, New York, and Pennsylvania.	Formerly Decker Limestone. Includes Wallpack Center and Clove Brook Members. (Epstein, Epstein, Spink, and Jennings, 1967.)

Dedham Granodiorite	pre-Carboniferous	eastern Massachusetts	Age changed from early Paleozoic(?) to pre-Carboniferous. (Chute, 1966.)
Deer Creek Limestone (of Shawnee Group)	Late Pennsylvanian (Virgil)	northeastern Kansas	Deer Creek Limestone in area of report includes these members (ascending order): Ozawkie Limestone, Oskaloosa Shale, Rock Bluff Limestone, Larsh Shale, Burroak Shale, Ervine Creek Limestone. (Johnson and Adkison, 1967.)
Depue Limestone Member (of Coeymans Formation).	Early Devonian	Pennsylvania and New Jersey	New name adopted. (Epstein, Epstein, Spink, and Jennings, 1967.)
Devils Pocket Formation (of Amsden Group)	Middle Pennsylvanian	western Montana	Formerly of Big Snowy Group. Age changed from Mississippian or Pennsylvanian to Middle Pennsylvanian (Atoka and Des Moines(?)). (Maughan and Roberts, 1967.)
Diablo Formation	Early and Late Permian (Guadalupe).	Nevada	Age changed from Permian to Early and Late Permian (Guadalupe). (Ketner, 1967.)
Dimple Limestone	Middle Pennsylvanian	west Texas	Age changed from Pennsylvanian to Middle Pennsylvanian. (Oriel, Myers, and Crosby, 1967.)
Dinosaur Canyon Member (of Moenave Formation).	Late Triassic(?)	southwestern Utah	Formerly Dinosaur Canyon Sandstone Member and remains as such outside of area of report. (Wilson and Stewart, 1967.)
Doniphan Shale Member (of Lecompton Limestone).	Late Pennsylvanian (Virgil)	northeastern Kansas	Doniphan Shale Member of Condra (1927) adopted. (Johnson and Adkison, 1967.)
Double Bluff Drift	Pleistocene	northwestern Washington	New name adopted. (Easterbrook, Crandell, and Leopold, 1967.)
Douglas Group	Pennsylvanian (Virgil)	northeastern Kansas	In Kansas base of Douglas Group lowered to top of Lansing Group. (Johnson and Adkison, 1967.)
Douglass Mesa Gravel	Pleistocene (Kansan or Yarmouth).	central Colorado	New name adopted. (Varnes and Scott, 1967.)
Duttonville Member (of Rondout Formation)	Late Silurian or Early Devonian.	New Jersey and Pennsylvania	New name adopted. (Epstein, Epstein, Spink, and Jennings, 1967.)
El Paso Dolomite	Early Ordovician	southwestern New Mexico	Formerly El Paso Limestone or Formation in report area. Both terms remain in good usage elsewhere. (Pratt, 1967.)
Epitaph Dolomite (of Naco Group)	Early Permian	Arizona	Age changed from Permian to Early Permian. (McKee, 1967.)
Epitaph Formation	do	southern Arizona	Epitaph Formation in report area; Epitaph Dolomite in good usage elsewhere. (Creasey, 1967a.)
Ervine Creek Limestone Member (of Deer Creek Limestone).	Late Pennsylvanian (Virgil)	northeastern Kansas	Ervine Creek Limestone Member of Condra (1927) adopted. (Johnson and Adkison, 1967.)

CHANGES IN STRATIGRAPHIC NOMENCLATURE—Continued

Name	Age	Location	Revision and reference
Fairview Valley Formation	Permian and Permian(?)	California	Fairview Valley Formation of Bowen (1954) adopted. (Dibblee, 1967a.)
Falls City Limestone (of Admire Group)	Early Permian	northeastern Kansas	Age changed from Permian to Early Permian. (Johnson and Wagner, 1967.)
Five Point Limestone Member (of Janesville Shale).	Early Permian	northeastern Kansas	Age changed from Permian to Early Permian. (Johnson and Wagner, 1967.)
Flatbrookville Member (of New Scotland Formation).	Early Devonian	New Jersey, New York, and Pennsylvania.	New name adopted. (Epstein, Epstein, Spink, and Jennings, 1967.)
Foraker Limestone (of Council Grove Group)	Early Permian	northeastern Kansas	Age changed from Permian to Early Permian. (Johnson and Wagner, 1967.)
Fountain Formation	Middle and Late Pennsylvanian and Early Permian.	Wyoming, Montana, North Dakota, and South Dakota.	Age changed from Pennsylvanian and Permian to Middle and Late Pennsylvanian and Early Permian. (Maughan, 1967.)
Fraction Tuff	late Miocene	southern Nevada	Fraction Tuff in report area; Fraction Breccia in good usage elsewhere. (Ekren, Rogers, Anderson, and Botinelly, 1967.)
Funnel Creek Limestone	Early Cambrian	east-central Alaska	New name adopted. (Brabb, 1967.)
Galiuro Volcanics	middle Tertiary or younger	south-central Arizona	Age changed from middle Tertiary to middle Tertiary or younger. (Creasey, 1967b.)
Gaptank Formation	Middle and Late Pennsylvanian and Early Permian.	west Texas	Age changed from Pennsylvanian to Middle and Late Pennsylvanian and Early Permian. (Oriel, Myers, and Crosby, 1967.)
Garlock Formation	Permian and Permian(?)	southeastern California	Garlock Series of Dibblee (1952) adopted as Garlock Formation. (Dibblee, 1967a.)
Gem Hill Formation (of Tropico Group)	Oligocene(?) to middle Miocene(?).	do	Age changed from Miocene(?) to Oligocene(?) to middle Miocene(?). (Dibblee, 1967a.)
Giraffe Creek Member (of Twin Creek Limestone).	Late Jurassic	Wyoming, Idaho, and Utah	New name adopted. (Imlay, 1967.)
Goler Formation	Paleocene and Eocene	southeastern California	Goler Formation of Dibblee (1952) adopted. (Dibblee, 1967a).
Grand Pitch Formation	Early Cambrian(?)	northeastern Maine	Age changed from Cambrian(?) to Early Cambrian(?). (Neuman, 1967a.)
Grant Lake Member (of Ashlock Formation)	Late Ordovician (Cincinnatian)	eastern Kentucky	Grant Lake Member used in area from Richmond northeastward to Owingsville. Grant Lake Limestone used for area from Owingsville northward to Maysville. (Simmons, 1967b.)

Guajataca Member (of Cibao Formation)	late Oligocene and (or) early Miocene.	northwestern Puerto Rico	Age changed from Oligocene to late Oligocene and (or) early Miocene. (Monroe, 1967.)
Gunners Cove Formation	Oligocene(?)	Alaska	Age changed from Oligocene or early Miocene to Oligocene(?). (MacNeil, 1967.)
Halleck Formation	Early Permian	southeastern Alaska	New name adopted. (Muffler, 1967.)
Hamilton Island Limestone (of Hyd Group)	Late Triassic	do	New name adopted. (Muffler, 1967.)
Hamlin Shale Member (of Janesville Shale)	Early Permian	northeastern Kansas	Age changed from Permian to Early Permian. (Johnson and Wagner, 1967.)
Harmony Hills Tuff Member (of Quichapa Formation).	Oligocene or Miocene	southwestern Utah	Harmony Hills Tuff Member of Mackin (1960) adopted. (Averitt, 1967.)
Hartford Limestone Member (of Topeka Limestone).	Late Pennsylvanian (Virgil)	northeastern Kansas	Hartford Limestone Member of Moore, Frye, and Jewett (1944) reinstated. Original usage, Hartford Limestone, abandoned in 1912. (Johnson and Adkison, 1967.)
Haskell Limestone Member (of Lawrence Formation).	Pennsylvanian (Virgil)	do	Formerly a member of Stranger Formation; now basal member of revised Lawrence Formation. (Johnson and Adkison, 1967.)
Hasmark Formation	Middle and Late Cambrian	western Montana	Age changed from Late Cambrian to Middle and Late Cambrian. (Prinz, 1967.)
Hatch Hill Formation	Middle(?) and Upper Cambrian.	New York, Vermont	Hatch Hill Formation of Theokritoff (1959) adopted. (Zen, 1967.)
Hawley Schist	Middle Ordovician	northwestern Massachusetts	Age changed from Ordovician to Middle Ordovician. (Chidester, Hatch, Osberg, Norton, and Hartshorn, 1967.)
Hawxby Shale Member (of Onaga Shale)	Early Permian	northeastern Kansas	Age changed from Permian to Early Permian. (Johnson and Wagner, 1967.)
Haymond Formation	Middle Pennsylvanian	west Texas	Age changed from Pennsylvanian to Middle Pennsylvanian. (Oriel, Myers, and Crosby, 1967.)
Helderberg Group	Early Devonian	New Jersey and Pennsylvania	Minisink Limestone included in Helderberg Group in report area. (Epstein, Epstein, Spink, and Jennings, 1967.)
Hermit Shale (of Aubrey Group)	Early Permian (Leonard)	Utah and Arizona	Age changed from Permian to Early Permian (Leonard). (McKee, 1967.)
Hillard Limestone	Early Cambrian to Early Ordovician.	east-central Alaska	New name adopted. (Brabb, 1967).
Hodge Volcanic Formation	Mesozoic and Permian (Ochoa?).	California	Age changed from Mesozoic or older to Mesozoic and Permian (Ochoa?). (Ketner, 1967.)
Hole-In-The-Wall Tuff Member (of Isom Formation).	Oligocene or early Eocene	southwestern Utah	Hole-In-The-Wall Tuff Member of Mackin (1960) adopted. (Averitt, 1967.)

CHANGES IN STRATIGRAPHIC NOMENCLATURE—Continued

Name	Age	Location	Revision and reference
Hoosac Formation	Early(?) Cambrian	western Vermont	Hoosac Formation as redefined by Skehan (1961) adopted in Vermont; Hoosac Schist remains in good usage in Massachusetts and Connecticut. (Zen, 1967.)
Horn Mountain Tuff Member (of Talkeetna Formation).	Early Jurassic	southwestern Alaska	New name adopted. (Detterman and Hartsock, 1966.)
Horned Toad Formation	middle Pliocene	southeastern California	Age changed from early or middle Pliocene to middle Pliocene. (Dibblee, 1967a.)
Hoskin Lake Granite	middle Precambrian	Michigan and Wisconsin	Age changed from Precambrian to middle Precambrian. (Dutton and Linebaugh, 1967.)
Houchen Creek Limestone Bed (of Hamlin Shale Member).	Early Permian	northeastern Kansas	Age changed from Permian to Early Permian. (Johnson and Wagner, 1967.)
Hound Island Volcanics (of Hyd Group)	Late Triassic	southeastern Alaska	New name adopted. (Muffler, 1967.)
Hughes Creek Shale Member (of Foraker Limestone).	Early Permian	northeastern Kansas	Age changed from Permian to Early Permian. (Johnson and Wagner, 1967.)
Hunton Formation	Silurian and Devonian	do	Hunton Formation used in area of report; Hunton Limestone or Hunton Group in good usage elsewhere. (Johnson and Adkison, 1967.)
Husted Alluvium	Recent	central Colorado	New name adopted. (Varnes and Scott, 1967.)
Hyd Formation	Late Triassic	southeastern Alaska	Raised to group rank in report area; includes (ascending order) Burnt Island Conglomerate, Cornwallis Limestone, Hamilton Island Limestone, and Hound Island Volcanics. Hyd Formation remains in good usage elsewhere. (Muffler, 1967.)
Iatan Limestone Member (of Stranger Formation).	Pennsylvanian (Virgil)	northeastern Kansas	Iatan Limestone reduced to member rank and placed in revised Stranger Formation. (Johnson and Adkison, 1967.)
Ilyirak Gravel	Tertiary or Quaternary	northwestern Alaska	New name adopted. (Campbell, 1967.)
Interlake Formation	Late Ordovician and Silurian	North Dakota, South Dakota, Wyoming, and Montana.	Interlake Formation of Baillie (1951) adopted. (Sandberg, 1967.)
Iowa Point Shale Member (of Topeka Limestone).	Late Pennsylvanian (Virgil)	northeastern Kansas	IowaPoint Shale Member of Condra (1927) adopted. (Johnson and Adkison, 1967.)
Ira Formation	Middle Ordovician	western Vermont	Formerly Ira Slate of Early Ordovician age. (Zen, 1967.)
Isom Formation	Eocene or early Oligocene	southwestern Utah	Isom Formation of Mackin (1960) adopted. (Blank and Mackin, 1967.)

Jackhammer Formation	Oligocene or early Miocene	southeastern California	New name adopted. (Dibblee, 1967a.)
Janesville Shale	Early Permian	northeastern Kansas	Age changed from Permian to Early Permian. (Johnson and Wagner, 1967.)
Jayuya Tuff	Early Cretaceous	west-central Puerto Rico	New name adopted. (Mattson, 1967.)
Johnson Shale	Early Permian	northeastern Kansas	Age changed from Permian to Early Permian. (Johnson and Wagner, 1967.)
Jones Point Shale Member (of Topeka Limestone).	Late Pennsylvanian (Virgil)	do	Jones Point Shale Member of Condra (1927) adopted. (Johnson and Adkison, 1967.)
Jones Ridge Limestone	Cambrian to Middle or Late Ordovician.	east-central Alaska	New name adopted. (Brabb, 1967.)
Kanwaka Shale (of Shawnee Group)	Late Pennsylvanian (Virgil)	northeastern Kansas	Kanwaka Shale divided into (ascending order) Clay Creek Limestone and Stull Shale Members. (Johnson and Adkison, 1967.)
Katahdin Quartz Monzonite	Early Devonian	central Maine	Katahdin Quartz Monzonite of Hitchcock (1861) adopted. (Neuman, 1967a.)
Keku Volcanics	Late Triassic	southeastern Alaska	New name adopted. (Muffler, 1967.)
Kettle Creek Alluvium	Pleistocene	central Colorado	New name adopted. (Varnes and Scott, 1967.)
King Hill Shale Member (of Lecompton Limestone).	Late Pennsylvanian (Virgil)	northeastern Kansas	King Hill Shale Member of Condra (1927) adopted. (Johnson and Adkison, 1967.)
Klondike Mountain Formation	Oligocene and Miocene(?)	northeastern Washington	Age changed from Oligocene to Oligocene and Miocene(?). (Muessig, 1967.)
Kneeling Nun Tuff	Miocene(?)	southwestern New Mexico	Formerly Kneeling Nun Rhyolite Tuff. (Pratt, 1967.)
Kuiu Limestone	Late Silurian	southeastern Alaska	New name adopted. (Muffler, 1967.)
Kushtaka Formation	Eocene and Oligocene(?)	southern Alaska	Age changed from Oligocene or Miocene to Eocene and Oligocene(?). (Plafker, 1967.)
Lago Garzas Formation	Late Cretaceous	west-central Puerto Rico	New name adopted. (Mattson, 1967.)
Lake Valley Limestone	Early Mississippian	southwetsern New Mexico	Andrecito Member of Laudon and Bowsher (1949) adopted and made lowest member of formation. (Jones, Hernon, and Moore, 1967.)
Lane Mountain Andesite	Pliocene(?)	southeastern California	New name adopted. (Dibblee, 1967a.)
Larsh Shale Member (of Deer Creek Limestone)	Late Pennsylvanian (Virgil)	northeastern Kansas	Larsh Shale Member of Condra (1927) adopted. (Johnson and Adkison, 1967.)
Lawrence Formation (of Douglas Group)	Pennsylvanian (Virgil)	do	Formerly Lawrence Shale. Base of formation lowered to base of Haskell Limestone Member. Formation includes (ascending order) Haskell Limestone, Robbins Shale, Ireland Sandstone, and Amazonia Limestone Members. (Johnson and Adkison, 1967.)

CHANGES IN STRATIGRAPHIC NOMENCLATURE—Continued

Name	Age	Location	Revision and reference
Leach Canyon Tuff Member (of Quichapa Formation).	Oligocene or Miocene	southwestern Utah	Leach Canyon Tuff Member of Mackin (1960) adopted. (Averitt, 1967.)
Lecompton Limestone (of Shawnee Group)	Late Pennsylvanian (Virgil)	northeastern Kansas	The following members have been adopted for the Lecompton Limestone (ascending order): Spring Branch Limestone, Doniphan Shale, Big Springs Limestone, Queen Hill Shale, Beil Limestone, King Hill Shale, and Avoca Limestone Members. (Johnson and Adkison, 1967.)
Lee Formation	Early Pennsylvanian	east-central Kentucky	Includes Livingston Conglomerate Member in area of report. (Weir, 1967.)
Leeds Creek Member (of Twin Creek Limestone).	early Late Jurassic	Wyoming, Utah, and Idaho	New name adopted. (Imlay, 1967.)
Lehman Ridge Gravel	Pleistocene (Nebraskan or Aftonian).	central Colorado	New name adopted. (Varnes and Scott, 1967.)
Lincoln Creek Formation	late Eocene to early Miocene	southwestern Washington	New name adopted. (Beikman, Rau, and Wagner, 1967.)
Livingston Conglomerate Member (of Lee Formation).	Early Pennsylvanian	east-central Kentucky	Livingston Conglomerate Member of Miller (1910) adopted. (Weir, 1967.)
Llaves Member (of San Jose Formation)	early Eocene	northwestern New Mexico	New name adopted. (Baltz, 1967.)
Lodgepole Limestone (of Madison Group)	Early Mississippian	Montana, Wyoming, Utah, Idaho, and (subsurface) North Dakota.	Cottonwood Canyon Member adopted as basal member of Lodgepole Limestone. (Sandberg and Klapper, 1967.)
Long Creek Limestone Member (of Foraker Limestone).	Early Permian	northeastern Kansas	Age changed from Permian to Early Permian. (Johnson and Wagner, 1967.)
Longmeadow Sandstone	Late Triassic	Massachusetts	Name abandoned. (Hartshorn and Koteff, 1967.)
McCloud Limestone	Early Permian (Leonard and Wolfcamp).	California	Age changed from Permian to Early Permian (Leonard and Wolfcamp). (Ketner, 1967.)
Madera Limestone (of Magdalena Group)	Middle and Late Pennsylvanian and Early Permian (locally).	central New Mexico	In report area, age changed from Middle and Late Pennsylvanian to Middle and Late Pennsylvanian and Early Permian. (Myers, 1967.)
Madison Limestone	Early Mississippian and Devonian.	Utah, Idaho, Colorado, Wyoming, Montana, and South Dakota.	Cottonwood Canyon Member adopted as basal member of Madison Limestone. (Sandberg and Klapper, 1967.)
Maravillas Formation	Late Cretaceous	west-central Puerto Rico	New name adopted. (Mattson, 1967.)

Marinette Quartz Diorite	middle Precambrian	Michigan and Wisconsin	Age changed from Precambrian to middle Precambrian. (Dutton and Linebaugh, 1967.)
Marsh Creek Breccia Member (of Talkeetna Formation).	Early Jurassic	southwestern Alaska	New name adopted. (Detterman and Hartsock, 1966.)
Marsh Creek Sandstone Member (of Lee Formation).	Early Pennsylvanian	southeastern Kentucky	New name adopted. (Tabor, 1967.)
Marsh Creek Sandstone Tongue (of Lee Formation).	do	do	New name adopted. (Loney, 1967.)
Martinsburg Formation	Middle and Late Ordovician	Pennsylvania and New Jersey	Martinsburg Formation in report area divided into (ascending order) Bushkill, Ramseyburg, and Pen Argyl Members. (Drake and Epstein, 1967.)
Mashipacong Member (of Rondout Formation)	Early Devonian	New Jersey, New York, and Pennsylvania.	New name adopted. (Epstein, Epstein, Spink, and Jennings, 1967.)
Maskenozha Member (of New Scotland Formation).	do	do	New name adopted. (Epstein, Epstein, Spink, and Jennings, 1967.)
Mattawamkeag Formation	Ordovician or Silurian	northeastern Maine	New name adopted. (Ekren and Frischknecht, 1967.)
Meeke Mine Formation	late Pliocene and (or) early Pleistocene(?).	southeastern California	New name adopted. (Dibblee, 1967a.)
Mesquite Schist	Precambrian(?)	southeastern California	Mesquite Schist of Dibblee (1952) adopted. (Dibblee, 1967a.)
Minisink Limestone (of Helderberg Group)	Early Devonian	Pennsylvania and New Jersey	New name adopted. (Epstein, Epstein, Spink, and Jennings, 1967.)
Minnekahta Limestone	Early Permian (Leonard)	Wyoming, Montana, North Dakota, and South Dakota.	Age changed from Permian to Early Permian (Leonard). (Maughan, 1967.)
Mint River Glaciation	Pleistocene (Wisconsin)	northwestern Alaska	New name adopted. (Sainsbury, 1967.)
Moenave Formation	Late Triassic(?)	southwestern Utah	Moenave Formation divided into (ascending order) Dinosaur Canyon, Whitmore Point, and Springdale Sandstone Members. (Wilson and Stewart, 1967.)
Monkton Quartzite	Early Cambrian	western Vermont	Monkton Formation used in southwestern Vermont. Monkton Quartzite in good usage elsewhere in Vermont. (Zen, 1967.)
Monserrate Formation	middle(?) Eocene	west-central Puerto Rico	Monserrate Formation of Pessagno (1960) adopted. (Mattson, 1967.)
Montoya Group	Middle and Late Ordovician	southwestern New Mexico	Montoya Group in report area. Montoya Dolomite in good usage elsewhere. (Pratt, 1967.)
Monument Creek Alluvium	Pleistocene	central Colorado	New name adopted. (Varnes and Scott, 1967.)
Naknek Formation	Late Jurassic	southwestern Alaska	Naknek Formation divided into (ascending order) Chisik Conglomerate, lower sandstone, Snug Harbor Siltstone, and Pomeroy Arkose Members. (Detterman and Hartsock, 1966.)

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CHANGES IN STRATIGRAPHIC NOMENCLATURE—Continued

Name	Age	Location	Revision and reference
Nasorak Formation (of Lisburne Group)	Early and Late Mississippian	northwestern Alaska	Cape Thompson Member adopted as member of Nasorak Formation. (Campbell, 1967.)
Needles Range Formation	Eocene or early Oligocene	southwestern Utah	Needles Range Formation of Mackin (1960) adopted. (Blank and Mackin, 1967.)
Neenach Volcanic Formation	Oligocene(?) and lower or middle Miocene.	southeastern California	New name adopted. (Dibblee, 1967a.)
New Scotland Formation (of Helderberg Group)	Early Devonian	New Jersey, New York, and Pennsylvania.	Consists of (ascending order) Maskenozha and Flatbrookville Members. Formerly New Scotland Limestone, which remains in good usage outside report area. (Epstein, Epstein, Spink, and Jennings, 1967.)
Newburyport Quartz Diorite	pre-Carboniferous	Massachusetts and New Hampshire.	Age changed from Precambrian or Late Ordovician to pre-Carboniferous. (Chute, 1966.)
Normanskill Shale	Middle Ordovician	eastern New York	Now includes Austin Glen Member. (Zen, 1967.)
Oldham Member (of Crab Orchard Formation)	Middle Silurian	central Kentucky	Oldham Member of Foerste (1906) adopted. (Simmons, 1967a.)
Onaga Shale (of Admire Group)	Early Permian	northeastern Kansas	Age changed from Permian to Early Permian. (Johnson and Wagner, 1967.)
Opal Mountain Volcanic Formation	Oligocene(?) to middle Miocene(?).	southeastern California	New name adopted. (Dibblee, 1967a.)
Opeche Shale	Early Permian (Leonard)	Wyoming, Montana, North Dakota, and South Dakota.	Age changed from Permian to Early Permian (Leonard). (Maughan, 1967.)
Oro Grande Formation	Carboniferous(?)	southeastern California	Age changed from Paleozoic to Carboniferous (?). (Dibblee, 1967a.)
Oskaloosa Shale Member (of Deer Creek Limestone).	Late Pennsylvanian (Virgil)	northeastern Kansas	Oskaloosa Shale Member of Moore (1936) adopted. (Johnson and Adkison, 1967.)
Oso Canyon Formation	Late Miocene	southeastern California	New name adopted. (Dibblee, 1967a.)
Oswaldo Formation	Middle and Late Pennsylvanian.	southwestern New Mexico	Age changed from Pennsylvanian to Middle and Late Pennsylvanian. (Jones, Hernon, and Moore, 1967.)
Oswaldo Limestone	do	do	Oswaldo Limestone in report area. Oswaldo Formation remains in good usage elsewhere. (Pratt, 1967.)
Ottauquechee Formation	Middle Cambrian to Early Ordovician.	western Vermont	Age changed from Middle Cambrian to Middle Cambrian to Early Ordovician. (Zen, 1967.)

Ozawkie Limestone Member (of Deer Creek Limestone).	Late Pennsylvanian (Virgil)	northeastern Kansas	Ozawkie Limestone Member of Condra (1935) adopted. (Johnson and Adkison, 1967.)
Pablo Formation	Permian (Ochoa?)	Nevada	Age changed from Permian(?) to Permian (Ochoa?). (Ketner, 1967.)
Paveloff Siltstone Member (of Chinitna Formation).	Late Jurassic	southwestern Alaska	New name adopted. (Detterman and Hartsock, 1966.)
Pawlet Formation	late Middle Ordovician	western Vermont	Pawlet Formation of Zen (1961) adopted. (Zen, 1967.)
Pedee Group	Pennsylvanian	northeastern Kansas	Pedee Group no longer used in Kansas. (Johnson and Adkison, 1967.)
Pen Argyl Member (of Martinsburg Formation)	Late Ordovician	eastern Pennsylvania	Pen Argyl Member of Behre (1927) adopted. (Drake and Epstein, 1967.)
Peppersauce Member (of Abrigo Formation)	Middle(?) and Late Cambrian	southern Arizona	Peppersauce Member of Stoyanow (1936) adopted. (Creasey, 1967b.)
Percha Shale	Late Devonian	southwestern New Mexico	Percha Shale divided into Ready Pay (lower) and Box (upper) Members. (Jones, Hernon, and Moore, 1967.)
Perryville Member (of Lexington Limestone)	Middle Ordovician	Kentucky	Formerly Perryville Limestone. Includes Salvisa Bed. (Neuman, 1967b.)
Peters Valley Member (of Coeymans Formation)	Early Devonian	New Jersey and Pennsylvania	New name adopted. (Epstein, Epstein, Spink, and Jennings, 1967.)
Pickhandle Formation	Oligocene(?) to middle Miocene(?).	Southeastern California	Pickhandle Formation of Bowen (1954) adopted. (Dibblee, 1967a.)
Pine Valley Gravel	Pleistocene (Illinoian and Sangamon age).	central Colorado	New name adopted. (Varnes and Scott, 1967.)
Pioneer Formation	Precambrian	southern Arizona	Base of Pioneer Formation revised downward to include the Scanlan Conglomerate Member in area of report. (Creasey, 1967b.)
Plum Creek Member (of Crab Orchard Formation).	Early Silurian	central Kentucky	Plum Creek Member of Foerste (1906) adopted. (Simmons, 1967a.)
Plymouth Marble	Early Cambrian(?)	western Vermont	Age changed from Early Cambrian to Early Cambrian(?). (Zen, 1967.)
Pomeroy Arkose Member (of Naknek Formation).	Late Jurassic	southwestern Alaska	Redefined to include Pomeroy Member and upper sandstone member of Kirschner and Minard (1949). (Detterman and Hartsock, 1966.)
Ponaganset Gneiss	Mississippian(?) or older	northern Rhode Island	New name adopted. (Quinn, 1967.)
Portage Creek Agglomerate Member (of Talkeetna Formation).	Early Jurassic	southwestern Alaska	New name adopted. (Detterman and Hartsock, 1966.)
Port Ewen Shale (of Helderberg Group)	Early Devonian	New York, New Jersey, and Pennsylvania.	Port Ewen Shale used in area of report. (Epstein, Epstein, Spink, and Jennings, 1967.)
Possession Drift	Pleistocene	northwestern Washington	New name adopted. (Easterbrook, Crandell, and Leopold, 1967.)

CHANGES IN STRATIGRAPHIC NOMENCLATURE—Continued

Name	Age	Location	Revision and reference
Poultney Slate	Early and Middle Ordovician	western Vermont	Age changed from Early Ordovician to Early and Middle Ordovician. (Zen, 1967.)
Prida Formation (of Star Peak Group)	Early, Middle, and Late Triassic.	northwestern Nevada	Age changed from Middle Triassic to Early, Middle, and Late Triassic. (Silberling and Wallace, 1967.)
Punchbowl Formation	late Miocene and early Pliocene.	southwestern California	Age changed from late Miocene to late Miocene and early Pliocene. (Dibblee, 1967a.)
Pybus Formation	Permian	southeastern Alaska	Formerly Pybus Dolomite. (Muffler, 1967.)
Quail Lake Formation	late Miocene	southeastern California	New name adopted. (Dibblee, 1967a.)
Queen Hill Shale Member (of Lecompton Limestone).	Late Pennsylvanian (Virgil)	northeastern Kansas	Queen Hill Shale Member of Condra (1927) adopted. (Johnson and Adkison, 1967.)
Quichapa Formation	Oligocene or early Miocene	southwestern Utah	Quichapa Formation of Mackin (1960) adopted. (Blank and Mackin, 1967.)
Do	do	do	Quichapa Formation divided into (ascending order) Leach Canyon Tuff Member, Bauers Tuff Member, and Harmony Hills Tuff Member. (Averitt, 1967.)
Rainvalley Formation (of Naco Group)	Early and Late(?) Permian (Leonard and Guadalupe(?)).	Arizona and New Mexico	Age changed from Permian to Early and Late(?) Permian. (McKee, 1967.)
Ramseyburg Member (of Martinsburg Formation).	Late(?) Ordovician	New Jersey and Pennsylvania	New name adopted. (Drake and Epstein, 1967.)
Rand Schist	Precambrian(?)	southeastern California	Rand Schist of Hulin (1925) adopted. (Dibblee, 1967a.)
Ravena Member (of Coeymans Limestone)	Early Devonian	southeastern New York	Ravena Member of Rickard (1962) adopted. (Epstein, Epstein, Spink, and Jennings, 1967.)
Ready Pay Member (of Percha Shale)	Late Devonian	southwestern New Mexico	Ready Pay Member of Stevenson (1944) adopted. (Jones, Hernon, and Moore, 1967.)
Red Buttes Quartz Basalt (of Tropico Group)	early Miocene(?)	southeastern California	Age changed from Pliocene(?) to early Miocene(?). (Dibblee, 1967a.)
Reeve Meta-andesite	Early and Late Permian (Guadalupe).	California	Age changed from Pennsylvanian to Early and Late Permian (Guadalupe). (Ketner, 1967.)
Regina Member (of San Jose Formation)	early Eocene	northwestern New Mexico	New name adopted. (Baltz, 1967.)
Renegade Tongue (of Wasatch Formation)	Eocene	northeastern Utah	New name adopted. (Cashion, 1967b.)
Rich Member (of Twin Creek Limestone)	Middle Jurassic	Utah, Wyoming and Idaho	New name adopted. (Imlay, 1967.)

Río Prieto Formation	middle Eocene	west-central Puerto Rico	New name adopted. (Mattson, 1967.)
Robbins Shale Member (of Lawrence Formation).	Late Pennsylvanian (Virgil)	northeastern Kansas	A member of the Lawrence Formation; formerly a member of the Stranger Formation. (Johnson and Adkison, 1967.)
Robinson Formation	Early and Late Permian (Guadalupe).	California	Age changed from Pennsylvanian to Early and Late Permian (Guadalupe). (Ketner, 1967.)
Robles Formation	Early and Late Cretaceous	west-central Puerto Rico	Age changed from Late Cretaceous to Early and Late Cretaceous. (Mattson, 1967.)
Rockabema Quartz Diorite	Ordovician	northern Maine	New name adopted. (Ekren and Frischknecht, 1967.)
Rock Bluff Limestone Member (of Deer Creek Limestone).	Late Pennsylvanian (Virgil)	northeastern Kansas	Rock Bluff Limestone Member of Condra (1927) adopted. (Johnson and Adkison, 1967.)
Rondout Formation	Late Silurian and Early Devonian.	New York, New Jersey, and Pennsylvania.	Rondout Formation in report area consists of (ascending) Duttonville, Whiteport Dolomite, and Mashipacong Members. (Epstein, Epstein, Spink, and Jennings, 1967.)
Saddleback Basalt (of Tropico Group)	early Miocene(?)	southeastern California	Age changed from Pliocene(?) to early Miocene(?). (Dibblee, 1967a.)
Saginaw Bay Formation	Mississippian and Pennsylvanian.	southeastern Alaska	New name adopted. (Muffler, 1967.)
Salem Gabbro-Diorite	pre-Carboniferous	eastern Massachusetts	Age changed from early Paleozoic(?) to pre-Carboniferous. (Chute, 1966.)
Saligvik Gravel	Tertiary or Quaternary	northwestern Alaska	New name adopted. (Campbell, 1967.)
Salvisa Bed (of Perryville Member)	Middle Ordovician	Kentucky	Salvisa Bed of Miller (1913) adopted. (Neuman, 1967b.)
San Andres Limestone	Early and Late Permian (Leonard and Guadalupe)	west Texas and New Mexico	Age changed from Permian to Early and Late Permian (Leonard and Guadalupe). (Oriel, Myers, and Crosby, 1967.)
San Angelo Sandstone (of Pease River Group)	Early Permian (Leonard)	west Texas	Age changed from Permian to Early Permian (Leonard). (Oriel, Myers, and Crosby, 1967.)
San Francisquito Formation	Paleocene and Eocene(?)	southeastern California	New name adopted. (Dibblee, 1967a.)
San Jose Formation	early Eocene	northwestern New Mexico	Name adopted. (Baltz, 1967.)
Sanpoil Volcanics	Eocene(?)	northeastern Washington	Age changed from Eocene or Oligocene to Eocene(?). (Muessig, 1967.)
Santa Margarita Formation	late Miocene and early Pliocene(?).	southeastern California	Santa Margarita Formation restricted from area of the report; Quail Lake Formation used instead. (Dibblee, 1967a.)
Sawatch Sandstone	Late Cambrian	central Colorado	Sawatch Sandstone used instead of Sawatch Quartzite in area of report. (Varnes and Scott, 1967.)

CHANGES IN STRATIGRAPHIC NOMENCLATURE—Continued

Name	Age	Location	Revision and reference
Scanlan Congomerate Member (of Pioneer Formation or Shale).	Precambrian	southern Arizona	Raised from bed to member. (Shride, 1967.)
Scatter Creek Rhyodacite	Eocene(?)	northeastern Washington	Age changed from Eocene or Oligocene to Eocene(?). (Muessig, 1967.)
Scherrer Formation (of Naco Group)	Early Permian	Arizona	Age changed from Permian to Early Permian. (McKee, 1967.)
Second Value Dolomite (of Montoya Group)	Middle and Late Ordovician	southwestern New Mexico	Second Value Dolomite of Entwistle (1944) adopted. (Pratt, 1967.)
Sedalia Dolomite	Early Mississippian	northeastern Kansas	Sedalia Dolomite used instead of Sedalia Limestone in area of the report. (Johnson and Adkison, 1967.)
Sevy Dolomite	Early and Middle(?) Devonian.	east-central Nevada	Age changed from Early(?) and Middle Devonian to Early and Middle(?) Devonian. (Drewes, 1967.)
Sharon Syenite	Carboniferous or older	eastern Massachusetts	Age changed from Devonian(?) to Carboniferous or older. (Chute, 1966.)
Shawnee Island Member (of Coeymans Formation).	Early Devonian	Pennsylvania and New Jersey	New name adopted. (Epstein, Epstein, Spink, and Jennings, 1967.)
Sheldon Limestone Member (of Topeka Limestone).	Late Pennsylvanian (Virgil)	northeastern Kansas	Sheldon Limestone Member of Condra (1930) adopted. (Johnson and Adkison, 1967.)
Shingle Pass Tuff	Miocene	southern Nevada	Shingle Pass Tuff of Cook (1960) adopted. (Ekren, Rogers, Anderson, and Botinelly, 1967.)
Sixmile Creek Formation (of Bozeman Group)	Miocene and Pliocene	southwestern Montana	New name adopted. (Robinson, 1967.)
Skooner Gulch Formation	early Miocene	northwestern California	Skooner Gulch Formation of Weaver (1944) adopted. (Addicott, 1967.)
Sliderock Member (of Twin Creek Limestone)	Middle Jurassic	Wyoming, Utah, and Idaho	New name adopted. (Imlay, 1967.)
Smoky Member (of Nopah Formation)	Late Cambrian	Nevada	Used as Smoky Member of Nopak Formation in the Specter Range, Nevada. (Ross, 1967.)
Snake River Group	Pleistocene and Recent	southeastern Idaho	Snake River Group includes Big Hole Basalt in southeastern Idaho. (Mundorff, 1967.)
Snug Harbor Siltstone Member (of Naknek Formation).	Late Jurassic	southwestern Alaska	New name adopted. (Detterman and Hartsock, 1966.)
Sonoma Range Formation	Ordovician(?)	northwestern Nevada	Name abandoned. (Gilluly, 1967.)

Sooke Formation	early Miocene(?)	Alaska	Age changed from Oligocene or Miocene, or both, to early Miocene(?). (MacNeil, 1967.)
Southern Belle Member (of Abrigo Formation)	Middle(?) and Late(?) Cambrian.	southern Arizona	Southern Belle Member of Stoyanow (1936) adopted. (Creasey, 1967b.)
Spring Branch Limestone Member (of Lecompton Limestone).	Late Pennsylvanian (Virgil)	northeastern Kansas	Spring Branch Limestone Member of Condra (1927) adopted. (Johnson and Adkison, 1967.)
Star Peak Group	Early to Late Triassic	northwestern Nevada	Star Peak raised to group rank everywhere. (Silberling and Wallace, 1967.)
Sterling Plutonic Group	Mississippian(?) or older	southeastern Connecticut	Age changed from pre-Pennsylvanian to Mississippian(?) or older. (Goldsmith, 1967.)
Stonehouse Canyon Member (of Tyler Formation).	Early Pennsylvanian	western Montana	New name adopted. (Maughan and Roberts, 1967.)
Stormville Member (of Coeymans Formation)	Early Devonian	Pennsylvania and New Jersey	Stormville Member of White (1882) adopted. (Epstein, Epstein, Spink, and Jennings, 1967.)
Stranger Formation (of Douglas Group)	Late Pennsylvanian (Virgil)	northeastern Kansas	Base of Stranger Formation lowered to top of Stanton Limestone and included in the Douglas Group. (Johnson and Adkison, 1967.)
Stull Shale Member (of Kanwaka Shale)	do	do	Stull Shale Member of Moore (1932) adopted. (Johnson and Adkison, 1967.)
Sugarlump Tuff	Miocene(?)	southwestern New Mexico	Formerly Sugarlump Tuffs. (Pratt, 1967.)
Swakane Biotite Gneiss	pre-Late Cretaceous	north-central Washington	Age changed from pre-Tertiary to pre-Late Cretaceous. (Cater and Crowder, 1967.)
Syrena Formation	Late Pennsylvanian	southwestern New Mexico	Age changed from Pennsylvanian to Late Pennsylvanian. (Jones, Hernon, and Moore, 1967.)
Talkeetna Formation	Early Jurassic	southwestern Alaska	Talkeetna Formation divided into (ascending order) Marsh Creek Breccia Member, Portage Creek Agglomerate Member, and Horn Mountain Tuff Member. (Detterman and Hartsock, 1966.)
Tallman Fanglomerate	Permian(?)	Nevada	Age changed from Permian to Permian(?). (Gilluly, 1967.)
Tapicitos Member (of San Jose Formation)	early Eocene	northwestern New Mexico	New name adopted. (Baltz, 1967.)
Tesnus Formation	Mississippian and Pennsylvanian.	west Texas	Age changed from Pennsylvanian to Pennsylvanian and Mississippian. (Oriel, Myers, and Crosby, 1967.)
Three C Member (of Abrigo Formation)	Middle and Late(?) Cambrian.	southern Arizona	New name adopted. (Creasey, 1967b.)
Tindir Group	Precambrian	east-central Alaska	Age changed from Precambrian and Early Cambrian(?) to Precambrian. (Brabb, 1967.)

CHANGES IN STRATIGRAPHIC NOMENCLATURE—Continued

Name	Age	Location	Revision and reference
Topeka Limestone (of Shawnee Group)	Late Pennsylvanian (Virgil)	northeastern Kansas	The Topeka Limestone has been divided into the following members: (ascending order) Hartford Limestone, Iowa Point Shale, Curzon Limestone, Jones Point Shale, Sheldon Limestone, and Turner Creek Shale Members. (Johnson and Adkison, 1967.)
Topsy Formation	post-early Oligocene(?) to pre-middle Miocene.	southeastern Alaska	New name adopted. (Plafker, 1967.)
Towle Shale Member (of Onaga Shale)	Early Permian	northeastern Kansas	Age changed from Permian to Early Permian. (Johnson and Wagner, 1967.)
Tropico Group	Oligocene(?) and Miocene	southeastern California	Age changed from Miocene(?) and Pliocene(?) to Oligocene(?) and Miocene. (Dibblee, 1967a.)
Turner Creek Shale Member (of Topeka Limestone).	Late Pennsylvanian (Virgil)	northeastern Kansas	Turner Creek Shale Member of Condra (1927) adopted. (Johnson and Adkison, 1967.)
Twin Creek Limestone	Middle and Late Jurassic	Wyoming, Idaho, and Utah	Twin Creek Limestone divided into following members: (ascending order) Gypsum Spring, Sliderock, Rich, Boundary Ridge, Watton Canyon, Leeds Creek, and Giraffe Creek Members. (Imlay, 1967.)
Tyler Formation (of Amsden Group)	Early Pennsylvanian	Montana	Tyler Formation of Freeman (1922) adopted. (Maughan and Roberts, 1967.)
Unga Conglomerate	middle Miocene	Alaska	Age changed from Miocene to middle Miocene. (MacNeil, 1967.)
Upham Dolomite Member (of Second Value Dolomite).	Middle and Late Ordovician	southwestern New Mexico	Upham Dolomite Member of Second Value Dolomite of Montoya Group in report area. Elsewhere Upham Dolomite Member of Montoya Dolomite remains in good usage. (Pratt, 1967.)
Vale Formation (of Clear Fork Group)	Early Permian (Leonard)	west Texas	Age changed from Permian to Early Permian (Leonard). (Oriel, Myers, and Crosby, 1967.)
Valmy Formation	Early, Middle, and Late Ordovician.	northwestern Nevada	Age changed from Early and Middle Ordovician to Early, Middle, and Late Ordovician in report area. (Gilluly, 1967.)
Vivi Quartz Diorite Porphyry	Eocene(?)	west-central Puerto Rico	New name adopted. (Mattson, 1967.)
Wallpack Center Member (of Decker Formation).	Late Silurian	New Jersey and Pennsylvania	New name adopted. (Epstein, Epstein, Spink, and Jennings, 1967.)

Wasatch Formation	Paleocene and Eocene	northeastern Utah	Includes Renegade Tongue at top, in area of report. (Cashion, 1967b.)
Wassataquoik Chert	Middle Ordovician	northern Maine	New name adopted. (Neuman, 1967a.)
Waterman Gneiss	Precambrian(?)	southeastern California	Waterman Gneiss of Bowen (1954) adopted. (Dibblee, 1967a.)
Watton Canyon Member (of Twin Creek Limestone).	early Late Jurassic	Utah, Idaho, and Wyoming	New name adopted. (Imlay, 1967.)
West Branch Shale Member (of Janesville Shale)	Early Permian	northeastern Kansas	Age changed from Permian to Early Permian. (Johnson and Wagner, 1967.)
West Castleton Formation	Early and Middle Cambrian	western Vermont	West Castleton Formation of Zen (1961) adopted. (Zen, 1967.)
Weston Shale Member (of Stranger Formation)	Pennsylvanian (Virgil)	northeastern Kansas	Formerly Weston Shale of Pedee Group. Now Weston Shale Member of Stranger Formation. (Johnson and Adkison, 1967.)
Westwood Granite	pre-Carboniferous	eastern Massachusetts	New name adopted. (Chute, 1966.)
Whidbey Formation	Pleistocene	northwestern Washington	New name adopted. (Easterbrook, Crandell, and Leopold, 1967.)
Whipple Marble Member (of Ira Formation)	Middle Ordovician	western Vermont	Whipple Marble Member of Fowler (1950) adopted. (Zen, 1967.)
Whiteport Dolomite Member (of Rondout Formation).	Early Devonian	New York, New Jersey, and Pennsylvania.	Used as Whiteport Dolomite Member in area of report. (Epstein, Epstein, Spink, and Jennings, 1967.)
Whitmore Point Member (of Moenave Formation).	Late Triassic(?)	southwestern Utah	Whitmore Point Member of Wilson (1967) adopted. (Wilson and Stewart, 1967.)
Willimantic Gneiss	Middle(?) Ordovician or older.	east-central Connecticut	Age changed from pre-Pennsylvanian to Middle(?) Ordovician or older. (Snyder, 1967.)
Winooski Dolomite	late Early and Middle(?) Cambrian.	western Vermont	Age changed from Early Cambrian to late Early and Middle(?) Cambrian. (Zen, 1967.)
Winsor Member (of Carmel Formation)	Late Jurassic	southwestern Utah	Formerly Winsor Formation. (Cashion, 1967a.)
Yakataga Formation	middle Miocene to early Pleistocene.	southern Alaska	Age changed from Miocene and Pliocene to middle Miocene to early Pleistocene. (Plafker, 1967.)
Yakutat Group	Late Jurassic(?) and Early Cretaceous.	southern Alaska	Age changed from Late(?) Cretaceous to Late Jurassic(?) and Early Cretaceous. (Plafker, 1967.)
Yauco Mudstone	Late Cretaceous	west-central Puerto Rico	Yauco Mudstone of Mitchell (1922) adopted. (Mattson, 1967.)
York Glaciation	Pleistocene (Wisconsin age)	northwestern Alaska	New name adopted. (Sainsbury, 1967.)
Zion Hill Quartzite Member (of Bull Formation).	Early Cambrian(?)	western Vermont	Zion Hill Quartzite Member of Ruedemann (1914) adopted. (Zen, 1967.)

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UPPER PALEOZOIC FORMATIONS OF THE MOUNTAIN CITY AREA, ELKO COUNTY, NEVADA

By R. R. Coats

In the Mountain City area of Elko County (fig. 1), the Mountain City copper mine worked ores from a stratigraphically restricted zone of the Valmy Formation of Ordovician age. The Valmy is overlain by a sequence of rocks, predominantly clastic, belonging to the overlap assemblage of Roberts, Hotz, Gilluly, and Ferguson (1958, p. 2838). Some of these formations were described and named in private reports by geologists of the Mountain City Mining Company, during the period after the discovery of the Mountain City copper mine, and these names were later used by T. B. Nolan (unpub. data, 1932). Several of these names were published by Granger, Bell, Simmons, and Lee (1957, p. 116, pl. 14).

GROSSMAN FORMATION

The Grossman Formation is here named for rocks in the vicinity of the Grossman Ranch, in the valley of Mill Creek, about 1,000 feet west of the Owyhee-Mountain City quadrangle boundary. The type locality is designated as the hill in the SE¼ sec. 4, T. 45 N., R. 53 E., about half a mile west of the Grossman house. Rocks of this formation crop out in the Mountain City and adjacent part of the Owyhee quadrangles in two areas. In the type area, they extend as patches along Mill Creek from the type locality eastward to the south slope of Banner Hill (California Hill on some maps), on the east side of Owyhee River. In the other area, about 2 miles farther south, they crop out in a roughly parallel belt in the valleys of Rocky Gulch and lower Haystack Creek.

The Grossman Formation is dominantly clastic, ranging from a coarse conglomerate to a siltstone and phyllite. The clasts in the conglomerate have been tectonically flattened; they consist chiefly of gray quartzite, black chert, phyllite, and magnetitiferous siltstone. The fresh rock is generally medium gray to greenish gray. In the coarser grained sandstone, a distinct pepper-and-salt appearance results from the contrast between the dark chert and the lighter colored quartzite.

The top and bottom of the formation are nowhere found in the same section, and attitudes are rarely determinable; the thickness of the formation may be as much as 2,000 feet. The formation rests unconformably on the Valmy Formation and is overlain unconformably by the Banner Formation.

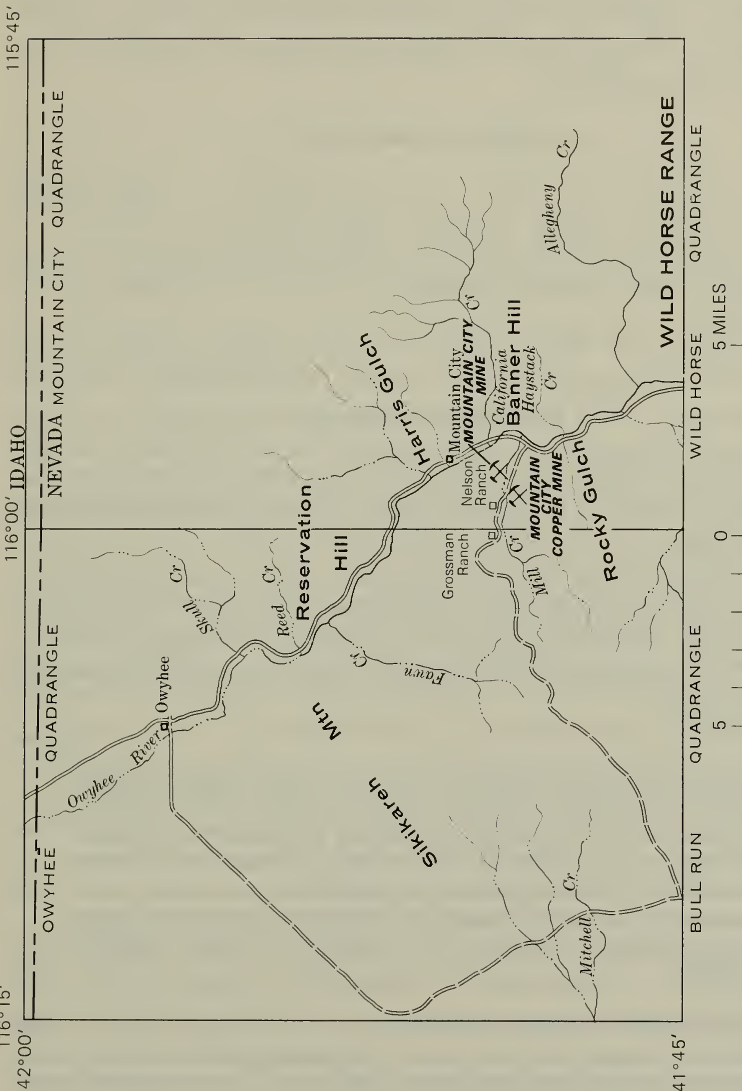


Figure 1.—Index map of the Mountain City and Owyhee quadrangles, Elko County, Nev., and Owyhee County, Idaho.

As no identifiable fossils have been found, the age of the formation is unknown; because it is post-Valmy and pre-Banner, it must be post-Middle Ordovician and pre-Late Mississippian. The clastic character and obvious derivation from the Valmy suggest that the formation postdates the beginning of the Late Devonian Antler orogeny in the area where it was deposited. It is therefore tentatively assigned to the Devonian or Mississippian.

BANNER FORMATION

The name Banner Limestone was first published by Granger, Bell, Simmons, and Lee (1957, p. 116), who credited the name to T. B. Nolan (unpub. data, 1932). The name Banner Formation rather than Banner Limestone is here employed, because of the varied lithology of the formation.

The south slope of Banner Hill (shown as California Hill on some maps) is here designated the type locality. The formation crops out in a narrow belt which trends nearly east-west and extends from the south slope of Banner Hill (just northeast of the confluence of Mill Creek and the Owyhee River in the Mountain City quadrangle) discontinuously westward to the headwaters of Fawn Creek in the Owyhee quadrangle.

The thickness of the Banner Formation varies widely. The maximum thickness exposed where outcrops are reasonably continuous is about 600 feet. A section measured in some mine workings, now inaccessible (E. C. Stephens, written commun., 1964), shows the following:

Banner Formation:

	Thickness (ft)
3. Limestone; arenaceous in lowest 100 feet; grades upward into soft massive bluish-gray limestone with two 6-inch beds of siliceous siltstone. Contact with overlying Nelson Formation not exposed	260
2. Sandstone, brown; grains medium to fine, subangular to rounded, and gray; tan-weathering siliceous siltstone	163
1. Conglomerate; composed mostly of angular to subrounded shale; some limestone fragments and occasional rounded quartzite boulders [1]	143
Total thickness of Banner Formation	566

[1] This thickness is greater than any seen on the surface. The mention of angular "shale" fragments suggests that conglomerate beds of part of the Grossman Formation were included in the measured section.

The Banner Formation rests with marked angular unconformity on the Valmy Formation and with slighter unconformity on the Grossman Formation. It grades upward, and perhaps also laterally, into the Nelson Formation; transitional material consists of a volcanic breccia, possibly a pépérite, with a calcareous matrix. The upper contact is drawn at the base of the rocks that contain a megascopically visible amount of volcanic material, probably more than 5 percent.

The Banner was originally considered to be of Late Mississippian age on the basis of determinations by G. H. Girty on several poor collections of fossils. Later, the views of paleontologists on the proper age assignment of this material changed, and an age of "probably Pennsylvanian or Permian (?)" was suggested (Granger and others, 1957, p. 116).

I was able to collect better preserved fossils in areas where the Banner is less metamorphosed; study of these permitted Helen Duncan (written commun., 1960) to correlate the Banner with limy shales in the Carlin area from which a Meramec (early Late Mississippian) fauna had been collected.

NELSON FORMATION

The Nelson Formation was originally called the Nelson Amphibolite by Granger, Bell, Simmons, and Lee (1957, p. 116), who credited the name to T. B. Nolan (unpub. data, 1932). It crops out as a west-trending belt of volcanic rocks adjacent to and north of the outcrop of the Banner Formation on Banner Hill and along the north side of Mill Creek. To the west, it is well exposed in the vicinity of the Nelson Ranch (S½ sec. 2, T. 45 N., R. 53 E.), the type locality; the Nelson there is approximately 600 feet thick, but it is somewhat thinner near the Owyhee-Mountain City quadrangle boundary and is much thicker in the headwaters of the east fork of Fawn Creek, where the discontinuous outcrops suggest a thickness of 2,500 feet.

The greater part of the formation consists of flows and tuff-breccias of andesitic and basaltic composition. The formation also includes minor sills of diabase and one lens of rhyolitic tuff. In the Mountain City quadrangle, it is a greenschist composed of tremolite-actinolite, chlorite, epidote, calcite, ilmenite, and andesine, in part altered to albite. In the meta-andesite, the amount of amphibolite is greatest and the recrystallized plagioclase is most calcic near the eastern end of the belt of exposures, where the rocks are closest to the quartz monzonite contact. Westward, the amphibole is lighter in color, the new feldspar is more albitic, and the rock is richer in chlorite. Locally the rock appears to be a metadiabase, probably metamorphosed sill, but exposures are not adequate to permit determination of the contact relations. The upper contact of the Nelson with the overlying Mountain City Formation is placed at the uppermost metavolcanic material.

The gradation from limestone of the Banner Formation into pépérite and lava of the Nelson Formation suggests that the Nelson is essentially contemporaneous with the Banner Formation. The Nelson is therefore tentatively assigned a Late Mississippian age.

MOUNTAIN CITY FORMATION

The Mountain City Formation was originally named by Granger, Bell, Simmons, and Lee (1957, p. 116), who credited the name to T. B. Nolan (unpub. data, 1932). They (pl. 14) showed it occurred at the Mountain City mine (not to be confused with the Mountain City copper mine). This long-inactive gold mine in the SE¼ sec. 2, T. 45 N., R. 53 E. at the crest of a hill north of Mill Creek is here designated as the type locality. The formation has been recognized only west of the Owyhee River, from the Mountain City mine to the headwaters of Fawn Creek. It forms a belt ranging in width from a few hundred feet to 2½ miles. It consists largely of fine-grained dark-gray to black siliceous schists that have a poorly defined schistosity that commonly parallels the bedding. The matrix of the schist consists mainly of quartz, but includes minor amounts of orthoclase and much very fine carbonaceous matter. Small amounts of sericite and calcite are present. Locally, near the contact with the quartz monzonite, porphyroblasts of andalusite, sometimes greenish, are developed. A few thin limy beds, as much as 2 feet thick, are also present, and small needles of tremolite have formed in these as a result of metamorphism. The total thickness is unknown; however, the minimum original thickness was probably at least 4,000 feet and perhaps as much as 10,000 feet.

The Mountain City Formation rests conformably on the Nelson Formation, but the upper contact has not been seen in the Mountain City area; the formation is limited above by the thrust contact with the Reservation Hill Formation, by the intrusive contact of the quartz monzonite, or by the overlapping Tertiary volcanic rocks.

The age of the formation is unknown, because no identifiable fossils have been found in it. It is questionably assigned to the Carboniferous because of its conformable relationship with the underlying Nelson Formation.

RESERVATION HILL FORMATION

The Reservation Hill Formation is here named for rocks exposed on Reservation Hill, the type locality, in secs. 22 and 23, T. 46 N., R. 53 E., Mountain City and Owyhee quadrangles. The exposures are just east of the highway from Mountain City to Owyhee, Nev., and just inside the Western Shoshone Indian Reservation.

The principal rock type in the Reservation Hill Formation is a fine-grained dolomitic sandstone or siltstone, pale gray on fresh fractures. It weathers creamy white to pale reddish brown (10*R* 6/4); the latter color is quite distinctive. The formation includes thick uninterrupted sequences in which siltstone beds, ½–2 inches thick, alternate rhythmically with thinner phyllite beds. Microscopically, the principal constituents of this rock type are quartz, orthoclase, oligoclase, and dolomite; diopside and themolite, and locally, coarsely prismatic wollastonite have formed as a result of metamorphism. A less important rock type ranges from metagraywacke through micaceous and tremolitic quartzite to graphitic phyllite. Metacherts, biotitic where impure, and pure quartzite are rare. At least one meta-andesite is present, locally attaining a thickness of as much as 200 feet; it is metamorphosed to actinolite-epidote-plagioclase schist, or to hornblende-plagioclase schist. One bed of metarhyolite tuff, about 2 feet thick, was observed; others may be present. Lenses of gray siliceous dolomitic limestone, as much as 50 feet thick, are present locally.

The Reservation Hill Formation rests in thrust contact on the Mountain City Formation along the ridge north of Mill Creek and westward to the valley of Fawn Creek. It is intruded by a Cretaceous quartz monzonite and overlapped by Tertiary and Quaternary deposits.

No fossil evidence for the age of the Reservation Hill Formation has been found. Lithologically, it does not resemble either the known Precambrian rocks of this region or the known Triassic rocks and is therefore assumed to be Paleozoic. R. J. Roberts (oral commun., 1961) suggested that it somewhat resembles the type Havallah Formation of Pennsylvanian and Permian age, and thus it is tentatively assigned an age of Pennsylvanian(?) and Permian(?).

NEW FORMATIONS ON KODIAK AND ADJACENT ISLANDS, ALASKA

By George W. Moore

Formal stratigraphic names have not previously been applied to rocks on Kodiak Island (fig. 2). The island is about 100 km (kilometers) wide and 160 km long and lies south of the center of the Alaskan subcontinent, about 50 km from the mainland. The formations newly named below were studied during the summers of 1962, 1963, and 1965.

UYAK FORMATION

The Uyak Formation is here named for the village of Uyak, which is on the northwest coast of Kodiak Island on the west shore of Uyak Bay (fig. 2). The formation crops out as a belt about 10 km wide along the northwest coast of Kodiak, Uganik, Raspberry, and Afognak Islands. It corresponds to the northwest belt of the greenstone-schist group of Capps (1937).

The type section of the Uyak Formation is designated as the rocks exposed along the west shore of Uyak Bay, from a basal thrust fault 3 km south of Uyak to a point 4 km northwest of Uyak, where the formation goes under a cover of glacial drift. The formation is sheared and cut by faults, but its attitude is fairly uniform; beds strike N. 45° E. and dip 75° NW. The tops of the beds were identified at only a few places, but in each place the beds are upright. If the type section is continuous, a thickness of about 6,000 meters is exposed.

The principal rock types throughout the Uyak Formation are black shale and local schistose green tuff. A few shale and sandstone graded beds also occur. The middle third of the exposed part of the formation contains many beds of pillow basalt and red chert, and the upper third is characterized by thick layers of light-gray chert. Thin limestone lenses occur at two places in the formation: about 700 meters above the base and 400 meters below the top. The chert and basalt underlie ridges, whereas the tuff and shale underlie valleys.

The Uyak Formation is the oldest formation exposed on the Kodiak group of islands. It is thrust over younger rocks to the southeast; elsewhere its relationship to younger sedimentary formations is obscured by the water of Shelikof Strait.

Marine fossils collected from a limestone lens 700 meters above the base of the type section at 57°37.7′ N., 153°59.0′ W., and identified by N.J. Silberling (written commun., 1966) are of Late Triassic age. The Uyak Formation is therefore considered to be Triassic. It has been intruded by penecontemporaneous ultramafic rocks and by a middle Tertiary quartz diorite batholith.

The Uyak Formation correlates with Triassic rocks on the Kenai Peninsula, including chert- and basalt-bearing rocks that extend to Nuka Island Passage (Grant, 1915). It is equivalent to somewhat less deformed and more fossiliferous Triassic rocks directly across Shelikof Strait on Cape Kekurnoi.

KODIAK FORMATION

The Kodiak Formation is here named for Kodiak Island. It crops out along the center of the island in a northeast-trending belt about

FIGURE 2.—Index map of Kodiak and adjacent islands.

60 km wide that follows an anticlinorium overturned toward the southeast. The Kodiak Formation is the slate-graywacke group of Capps (1937).

The northwest flank of the anticlinorium is a fairly regular homocline in which the attitude of the bedding averages N. 45° E., 45° NW.

The type section of the Kodiak Formation is designated as the section along the west shore of Uyak Bay, a fiord which nearly bisects Kodiak Island. The base of the section is 4 km south of the head of the bay, where the lower part of the formation is intruded by a quartz diorite stock. The top of the section is 3 km south of the village of Uyak, where Triassic rocks have been thrust over the youngest exposed part of the Kodiak Formation. Faults and dikes cut the unit, but except locally near the base, the beds everywhere in the type section are upright. A calculation based on the average dip indicates that the Kodiak Formation in its type section is 30,000 meters thick.

This exceedingly thick formation consists of a very regular geosynclinal sequence of graded beds that average about 1 meter thick. The fine-grained layer at the top of each graded bed is generally slate, and the coarser layer is medium-grained sandstone. In some places in the lower part of the formation, the fine-grained layers are phyllitic, and in approximately the upper 4,000 meters, they are shaly. The Kodiak Formation is resistant to erosion and provides excellent outcrops.

Along the axis of the anticlinorium, the Kodiak Formation has been intruded by a middle Tertiary quartz diorite batholith, and no stratigraphic units older than the Kodiak occur there. On the southeast side of Kodiak Island, a continuous sequence with younger formations seems to exist, but the rocks are so sheared and deformed that all mapped formation boundaries are faults. The Kodiak Formation is distinguished from the next younger formation there primarily by the Kodiak Formation's lack of basalt and secondarily by its slaty foliation.

No fossils diagnostic of age were found in the formation during the present investigation, but Imlay and Reeside (1954, p. 228) reported that Ulrich (1904, pl. 12–13) described two species of *Inoceramus*—from approximately the middle of the formation—that occur elsewhere in the world in rocks of Late Cretaceous age. The Kodiak Formation is therefore considered here to be Cretaceous on the basis of superposition and this fauna.

The Kodiak Formation also underlies the southeastern part of Afognak Island. It is lithologically correlative on the Kenai Peninsula with the slate and graywacke between Nuka Island Passage and Resurrection Bay (Grant, 1915), and to the southwest on the Shumagin Islands, it is correlative with the Shumagin Formation of Burk (1965). The deep-water sedimentary deposits of the Kodiak Formation correlate on the Alaska Peninsula to the northwest with Cretaceous shallow marine and continental coal-bearing rocks studied by Jones and Detterman (1966) and by Burk (1965).

GHOST ROCKS FORMATION

The Ghost Rocks Formation is named here for Ghost Rocks, which lie on the southeast coast of Kodiak Island directly north of Sitkalidak Island (fig. 2). The unit is equivalent to the southeast belt of the greenstone-schist group of Capps (1937). It crops out in a belt about 10 km wide near the southeast shore of Kodiak Island and through the middle of Sitkalidak Island.

The Ghost Rocks Formation occurs approximately along the axis of an isoclinally folded synclinorium that trends northeast. The synclinorium has been cut by block faults in such a way that wherever the rocks have been carefully studied, older rocks to the northwest and younger rocks to the southeast rest against rocks of the Ghost Rocks Formation in fault contact.

The type section of the Ghost Rocks Formation is designated as the exposures along the north coast of Sitkalidak Island directly opposite Ghost Rocks across Sitkalidak Strait. The type section extends from a major fault on the west side of the head of Amee Bay to a fault on the east side of the mouth of McDonald Lagoon. Specifically, in this isoclinally folded section, the Ghost Rocks Formation includes (1) zeolite-bearing tuffaceous sandstone that crops out at the heads of McCord Bay and Sitkalidak Lagoon, (2) all beds of basalt lying along the synclinorium, and (3) all intervening rocks, consisting of hard claystone, sandstone, tuff, and graded beds, locally in the form of wildflysch. The formation is sheared, faulted, and folded. The internal stratigraphy has not been completely worked out, but the thickness appears to be approximately 5,000 meters. The formation is lithologically distinct, as it is a coherent belt of rocks that contains pillow basalt and tuff, which are not found in either the underlying or the overlying formations.

Capps (1937) correlated this belt of rocks with my Uyak Formation on the northwest side of Kodiak Island, which similarly contains pillow basalt; hence he considered it to be older than my Kodiak Formation. Where the Ghost Rocks Formation rests in fault contact with the Kodiak Formation, however, lithologies that were originally similar in each are more highly metamorphosed in the Kodiak Formation. Moreover, the lack of chert and limestone in the Ghost Rocks Formation makes it different from the Uyak Formation.

No fossils were found in the Ghost Rocks Formation. The similarity in geosynclinal character to formations that are older and younger suggests that the sequence of formations lacks unconformities. Also, an analysis of the thicknesses of similar lithologies in the successive formations and a hypothetical correlation of the volcanic rocks in the Ghost Rocks Formation with nearby intrusive rocks of known age suggest that the formation straddles the boundary between the Paleocene and the Eocene.

To the west, on the Alaska Peninsula, the Ghost Rocks Formation is believed to correlate with the lower part of the basalt-bearing Tolstoi Formation of Burk (1965), which contains fossils of Paleocene age. To the east in Prince William Sound, it correlates with the lower part of the basalt-bearing Orca Group, in which fossils of early Tertiary age have been found (Plafker and MacNeil, 1966, p. B67).

SITKALIDAK FORMATION

The Sitkalidak Formation is named here for Sitkalidak Island; off the southeast coast of Kodiak Island. The formation occurs mainly in a series of patches at the southeastern tips of points on Kodiak, Sitkalidak, and Sitkinak Islands. These points are generally separated by fiords, so the individual patches are about 20 km apart. The formation has been deformed into a series of tight folds that are commonly overturned.

The type section of the Sitkalidak Formation lies along the north coast and near the east end of Sitkalidak Island. It extends in a chiefly overturned section from the axis of an anticline, 3 km northwest of Cape Barnabas, to the base of a 20-meter conglomerate bed, 7 km northwest of Cape Barnabas. The formation consists of a rather uniform sequence of sandstone and siltstone graded beds about 3,000 meters thick that formed under geosynclinal conditions of deposition. A few conglomerate beds also occur in the unit. All mapped contacts with the underlying Ghost Rocks Formation follow faults, and the basal contact of the Sitkalidak Formation has not been reached at the base of the type section. The base is defined to be directly above the uppermost basalt or tuffaceous sandstone bed that marks the top of the Ghost Rocks Formation. The upper contact, except in the type section, where it is deliberately specified, is a transitional zone in which the graded beds of the Sitkalidak Formation (below) alternate with crossbedded sandstone or conglomerate (above) that contains coal fragments.

A fossil clam collected from about 300 meters below the top of the Sitkalidak Formation in the type area at 57°11.1′ N., 152°56.5′ W., is a new genus of Vesicomyidae, and a fossil crab, *Callianassa* aff. *C. porterensis*, from the same locality, indicates an Oligocene age (F. S. MacNeil, written commun., 1963). Evidence from superposition suggests that the Sitkalidak Formation is Eocene and Oligocene. To the northeast in Prince William Sound, the formation correlates with the upper part of the Orca Group (Plafker and MacNeil, 1966); on the Alaska Peninsula, it correlates with the upper part of the Tolstoi Formation of Burk (1965).

SITKINAK FORMATION

The Sitkinak Formation is named here for Sitkinak Island, which is about 30 km long and which lies 15 km southwest of Kodiak Island. The formation is in isolated patches along a belt about 250 km long, extending from Chirikof Island at the southwest to Dangerous Cape on Kodiak Island at the northeast. The type section is along the south shore of Sitkinak Island. The basal part includes beach and shallow-marine deposits, but the bulk of the formation is continental and consists of coal-bearing siltstone, sandstone, and conglomerate. In the type section, several half-meter-thick coal beds occur in association with well-preserved fossil leaves.

A complete, though folded, section of the Sitkinak Formation occurs at its type locality, where the formation is about 1,500 meters thick. The basal contact there, which is locally disturbed by faulting, intersects the south shore of Sitkinak Island at a small lagoon 800 meters east of the south entrance to Sitkinak Lagoon at the base of an alternating zone, where graded beds of the underlying Sitkalidak Formation are succeeded by conglomerate and crossbedded sandstone and siltstone that contain coal fragments. At the type section of the Sitkalidak Formation on Sitkalidak Island, the contact is at the stratigraphic base of an overturned 20-meter conglomerate bed 7 km northwest of Cape Barnabas.

At many of its known areas of occurrence, the Sitkinak Formation is the youngest bedrock unit present. In its type section, however, coal-bearing sandstone and siltstone are conformably overlain by marine siltstone containing lower Miocene fossils. The upper contact in the type section is about 200 meters west of the southernmost point of Sitkinak Island.

Identifiable plant fossils are abundant throughout the continental part of the Sitkinak Formation on Sitkinak Island. J. A. Wolfe (written commun., 1968) stated that collections from near the middle and near the top of the section are middle or late Oligocene in age. The Sitkinak Formation is considered here to be Oligocene. It correlates on the Alaska Peninsula with the coal-bearing Stepovak Series of Palache (1904; Stepovak Formation of Burk, 1965). On the east side of the Gulf of Alaska, it correlates with the lower parts of the Poul Creek and Katalla Formations (Plafker, 1967).

NARROW CAPE FORMATION

The Narrow Cape Formation is here named for Narrow Cape, near the east end of Kodiak Island. The type section is along the southwest coast of the cape, from its end northwestward about 1 km to the axis of a syncline where the youngest part of the formation is exposed.

At its type locality, the formation is 700 meters thick. The lower two-thirds consists of sandstone and a few conglomerate beds; the upper third consists of siltstone. On Sitkinak Island, 150 km southwest of the type locality, about 150 meters of siltstone is preserved along a synclinal axis.

At Narrow Cape, the formation rests unconformably on the Sitkalidak Formation of Eocene and Oligocene age. On Sitkinak Island, it rests conformably on the Sitkinak Formation of Oligocene age. The Narrow Cape Formation is the youngest bedrock formation exposed at each of these two areas of outcrop.

The Narrow Cape Formation contains a rich marine fauna. A collection from near the middle of the section at the type locality was determined by F. S. MacNeil (written commun., 1963) to be middle Miocene. A collection from near the base of the formation on Sitkinak Island was determined by MacNeil to be early Miocene. The age of the formation therefore is considered to be Miocene. The Narrow Cape Formation correlates on the Alaska Peninsula with the Bear Lake Formation of Burk (1965). On the east side of the Gulf of Alaska, it correlates with the upper parts of the Poul Creek and Katalla Formation and the lower part of the Yakataga Formation (Plafker, 1967).

TUGIDAK FORMATION

The Tugidak Formation is here named for Tugidak Island, which is about 10 km wide and 20 km long; this island lies approximately 25 km southwest of Kodiak Island. The Tugidak Formation is the only bedrock unit underlying the island, and it occurs there in a homocline dipping approximately 5° NE. The formation also occurs at the north end of Chirikof Island, where it dips about 10° N.

The type section of the Tugidak Formation is designated as the exposures along the west coast of Tugidak Island, from the south tip of the island to the northernmost exposure of bedrock. In its type section, the formation is approximately 1,500 meters thick. It consists of interbedded sandstone and siltstone characterized by randomly distributed pebbles and cobbles. A 1-meter-thick cobble-conglomerate bed occurs about 350 meters above the base. On Chirikof Island, the Tugidak Formation lies in fault contact with older rocks and is overlain with apparent conformity by an unnamed Pleistocene marine formation.

The Tugidak Formation is richly fossiliferous on Tugidak Island. Three collections of marine fossils spaced stratigraphically through the formation were determined to be of Pliocene age by F. S. MacNeil (written commun., 1963). A fossil snail, *Nassarius* cf. *N. Andersoni*, in float from near the base of the formation on Chirikof Island is also considered to be Pliocene by W. O. Addicott (oral commun., 1966). The Tugidak Formation correlates with the Tachilni Formation on the Alaska Peninsula (Burk, 1965). The upper part of it correlates with the "lower" part of the of the Yakataga Formation as exposed on Middleton Island, about 400 km northeast of Kodiak Island (George Plafker and F. S. MacNeil, oral commun., 1963) ; only the uppermost part of the Yakataga Formation is exposed on Middleton Island.

THREE NEWLY NAMED JURASSIC FORMATIONS IN THE McCARTHY C–5 QUADRANGLE, ALASKA

By E. M. MacKevett, Jr.

This report names and describes three Jurassic formations in the McCarthy C–5 quadrangle, Alaska: the Lubbe Creek, Nizina Mountain and Root Glacier Formations. Brief descriptions of the stratigraphy of these formations were included in a report by MacKevett and Imlay (1962), and their distributions were shown in a preliminary geologic map of the quadrangle (MacKevett, 1963). Earlier investigators either did not recognize the Jurassic rocks or lumped them with Cretaceous or Triassic rocks. Moffit (1938, pl. 2), however, showed two small patches of undifferentiated Jurassic rocks within the C–5 quadrangle.

The present report supplements previous reports by naming the formations, revising lithologic descriptions and age assignments, and providing additional stratigraphic information. This report is based on field investigations during the summers of 1961 and 1962, on pertinent laboratory studies, and on paleontologic studies by R. W. Imlay. M. C. Blake, Jr., ably assisted in the field during 1961, and the writer is grateful to him and to Imlay for their contributions.

The McCarthy C–5 quadrangle is on the south flank of the rugged and strongly dissected Wrangell Mountains (fig. 3). It is bounded by the 61°30′ and 61°45′ parallels and by the 142°30′ and the 142°52′30″ meridians. Alpine conditions reflected by glaciers, perennial snowfields, diverse surficial deposits related to glacial activity, and several arêtelike ridges characterize a large part of the quadrangle. The quadrangle is uninhabited, although the two largest of the famous Kennecott mines, the Bonanza and the Jumbo, are near its southwestern corner and formerly were thriving mining camps. The most practical mode of travel in the quadrangle is the helicopter.

The Lubbe Creek, Nizina Mountain, and Root Glacier Formations occupy part of a belt of Triassic and Jurassic rocks that trends

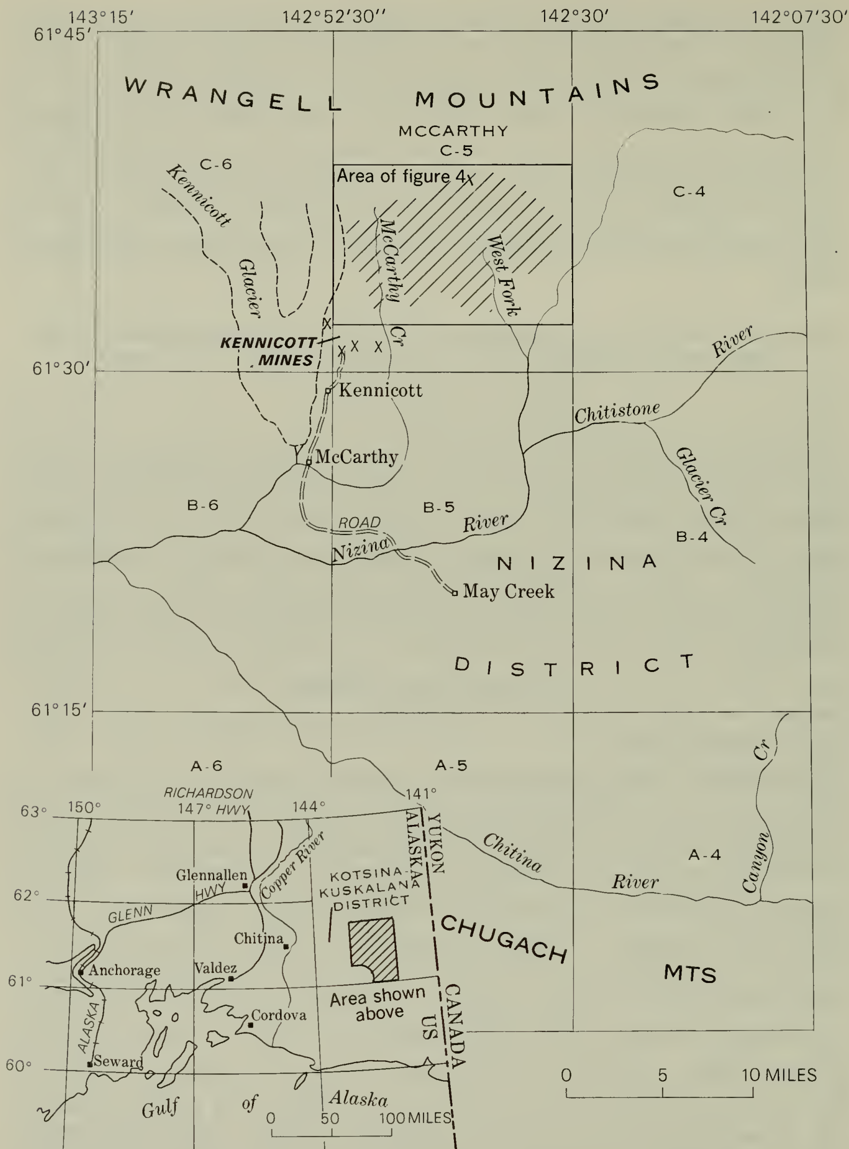


FIGURE 3.—Index map showing the McCarthy C–5 and nearby quadrangles.

northwestward across the middle of the quadrangle (fig. 4). These formations represent the upper part of an essentially concordant stratigraphic sequence whose sediments were deposited from the Late Triassic into the Late Jurassic. The major orogeny in the region was near the end of the Jurassic and (or) in the Early (pre-Albian) Cretaceous; the Jurassic rocks have been folded and faulted and are overlain unconformably by younger deposits. Despite modifications caused by the numerous folds and faults, the Jurassic rocks simulate a gentle northeast-dipping homocline in gross structure. The Lubbe Creek, Nizina Mountain, and Root Glacier Formations consist largely of very fine grained and fine-grained epiclastic rocks.

LUBBE CREEK FORMATION

Name and distribution

The Lubbe Creek Formation is named here from the excellent exposures at its type locality, along Lubbe Creek, a westward-flowing tributary of McCarthy Creek (figs. 4, 5). The formation also crops out on Bonanza Ridge, in the canyon walls that border the upper reaches of McCarthy Creek, and on both sides of the West Fork (fig. 4), all within the McCarthy C–5 quadrangle.

Two small patches of the Lubbe Creek Formation are exposed near the southwest corner of the McCarthy C–4 quadrangle (MacKevett and others, 1964), and the formation also extends into the McCarthy C–6 quadrange (MacKevett, 1965). No similar coeval rocks have been described from other nearby parts of Alaska.

General character, stratigraphic relations, and thickness

The Lubbe Creek Formation consists of impure spiculite and subordinate amounts of coquina. It constitutes an excellent marker horizon, being thin and lithologically distinctive, forming bold outcrops, and containing abundant fossils, including the diagnostic *Weyla.* Strata in the formation commonly are between ½ and 3 feet thick and, exceptionally, as much as 8 feet thick.

The Lubbe Creek Formation conformably overlies the upper member of the McCarthy Formation (figs. 5, 6), which is largely or entirely Early Jurassic. Its upper contact is a disconformity that separates it from the Nizina Mountain Formation or, in some places, from the Root Glacier Formation (figs. 5, 6). Locally, the Lubbe Creek is in fault contact with other rocks or is overlain by Quaternary surficial deposits.

The formation is about 300 feet in maximum thickness, but throughout most of its extent it is thinner because of erosion. Southeast of Nizina Mountain, the stratigraphic interval normally occupied by the Lubbe Creek Formation is marked by a hiatus that separates the upper member of the McCarthy Formation from the Nizina Mountain Formation.

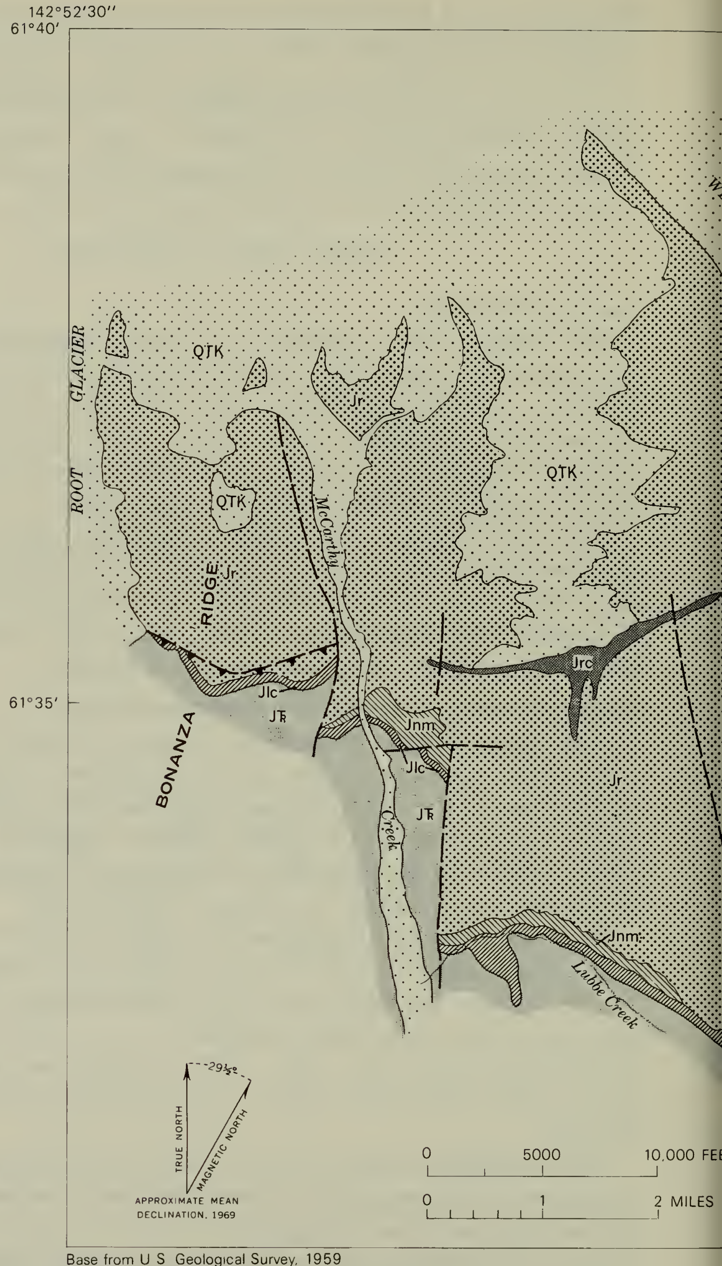
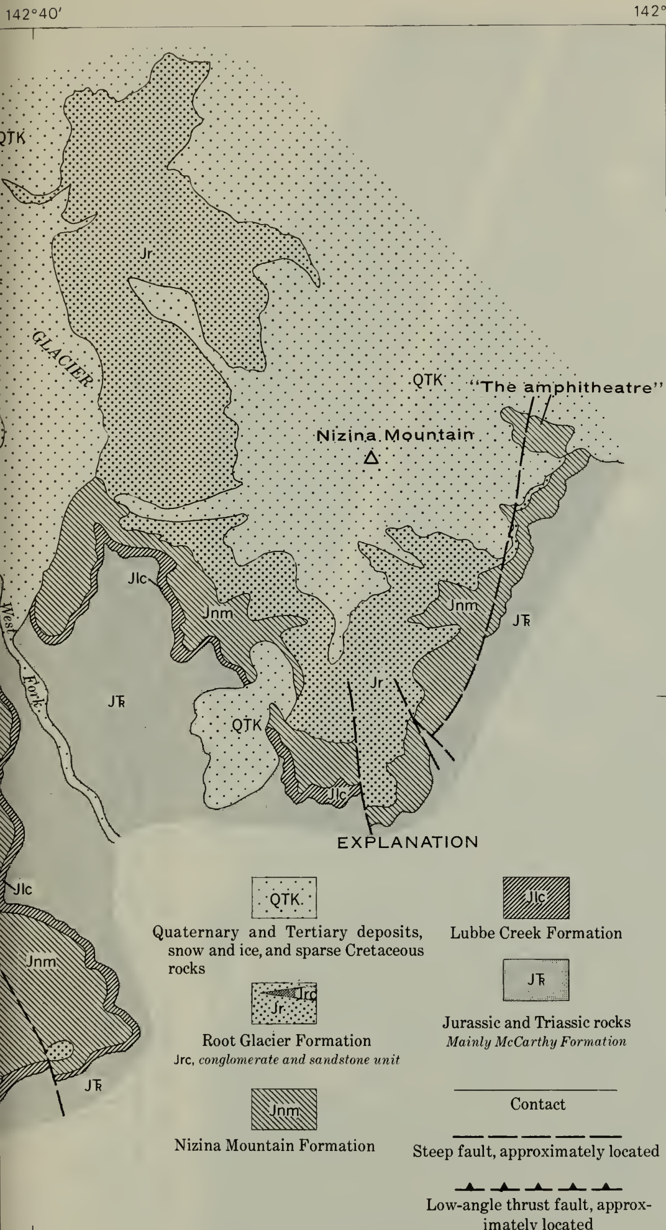


FIGURE 4.—Generalized geologic map of the Lubbe Creek, Nizina Mo



and Root Glacier Formations in the McCarthy C–5 quadrangle.

FIGURE 5.—Lubbe Creek Formation (Jlc) near the head of Lubbe Creek. The formation conformably overlies the upper member of the McCarthy Formation (JŦmu) and is overlain disconformably by the Nizina Mountain Formation (Jnm) or the Root Glacier Formation (Jr). The Lubbe Creek Formation here is about 150 feet thick.

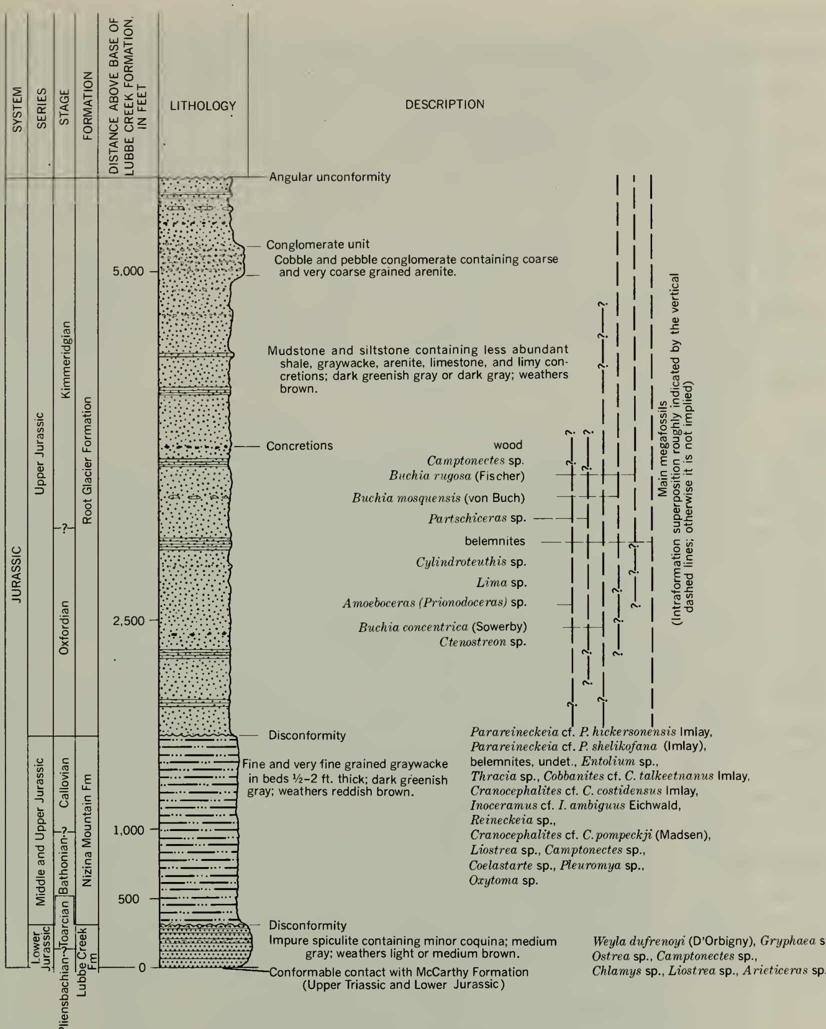


FIGURE 6.—Composite columnar section showing the Lubbe Creek, Nizina Mountain, and Root Glacier Formations.

Petrology and petrography

The Lubbe Creek Formation consists of impure spiculite and minor amounts of coquina; the rocks are medium gray where fresh and light or medium brown where weathered. Chert lenses as much as 10 feet long and 6 inches thick occur in some of the spiculites. The impure spiculites are fine-grained silica-rich rocks that contain organic and inorganic clasts in a chalcedony matrix. The clasts include spicules, Radiolaria, fragments of pelecypods and belemnites, calcite, quartz, dolomite, and plagioclase. Calcite is the dominant mineral of the clastic grains and of most shell fragments. The spiculites also contain minor amounts of chlorite, hematite, pyrite, carbonaceous material, ilemnite, biotite, and apatite. Most of the clasts are ragged to subangular and less than 0.2 millimeter in maximum dimension. The spicules are generally less than 0.3 mm long; commonly they are chalcedonic, and uncommonly, calcareous. A few have chloritic cores.

The coquina contains abundant poorly sorted bioclastic material, chiefly shells and shell fragments of megafossils, in a chalcedony matrix. Its subordinate clastic constituents are similar to those of the impure spiculites.

Age

The Lubbe Creek Formation is late Early Jurassic in age. The ammonite *Arieticeras* (USGS Mesozoic loc. 28531) provides excellent evidence for a late Pliensbachian age. The early Pliensbachian ammonite *Uptonia* (Mesozoic loc. 28675), less than 100 feet below the base of the Lubbe Creek Formation in the C–4 quadrangle, shows that no part of the formation is older than Pliensbachian. That the age is no younger than Toarcian is shown by an abundance of the Early Jurassic pelecypod *Weyla* in the upper part of the formation. Identification of this pelecypod as *Weyla dufrenoyi* (D'Orbigny) (Prof. S. W. Muller, oral commun., 1964) suggests a Toarcian age for the upper part of the formation.

In addition to *Weyla*, the fauna of the Lubbe Creek Formation, as identified by R. W. Imlay of the U.S. Geological Survey (written commun., 1963), includes: *Prodactylioceras*? sp., *Arieticeras*? sp., *Arieticeras* sp., *Gryphaea* sp., *Ostrea* sp., *Camptonectes* sp., *Astarte* sp., *Eopecten* sp., *Chlamys* sp., *Liostrea* sp., and brachiopods.

NIZINA MOUNTAIN FORMATION

Name and distribution

The Nizina Mountain Formation is named here for its type locality outcrops that partly girdle the ridge that extends southward from Nizina Mountain (fig. 4). The formation is well exposed on canyon walls of the West Fork. From these exposures it extends eastward around the nose of the ridge south of Nizina Mountain. Northeastward from there, it crops out almost continously along the east side of the ridge and extends to near "the amphitheatre," where it is overlapped by younger rocks (figs. 4, 7). The formation is intermittently exposed along the north side of Lubbe Creek and near the head of McCarthy Creek.

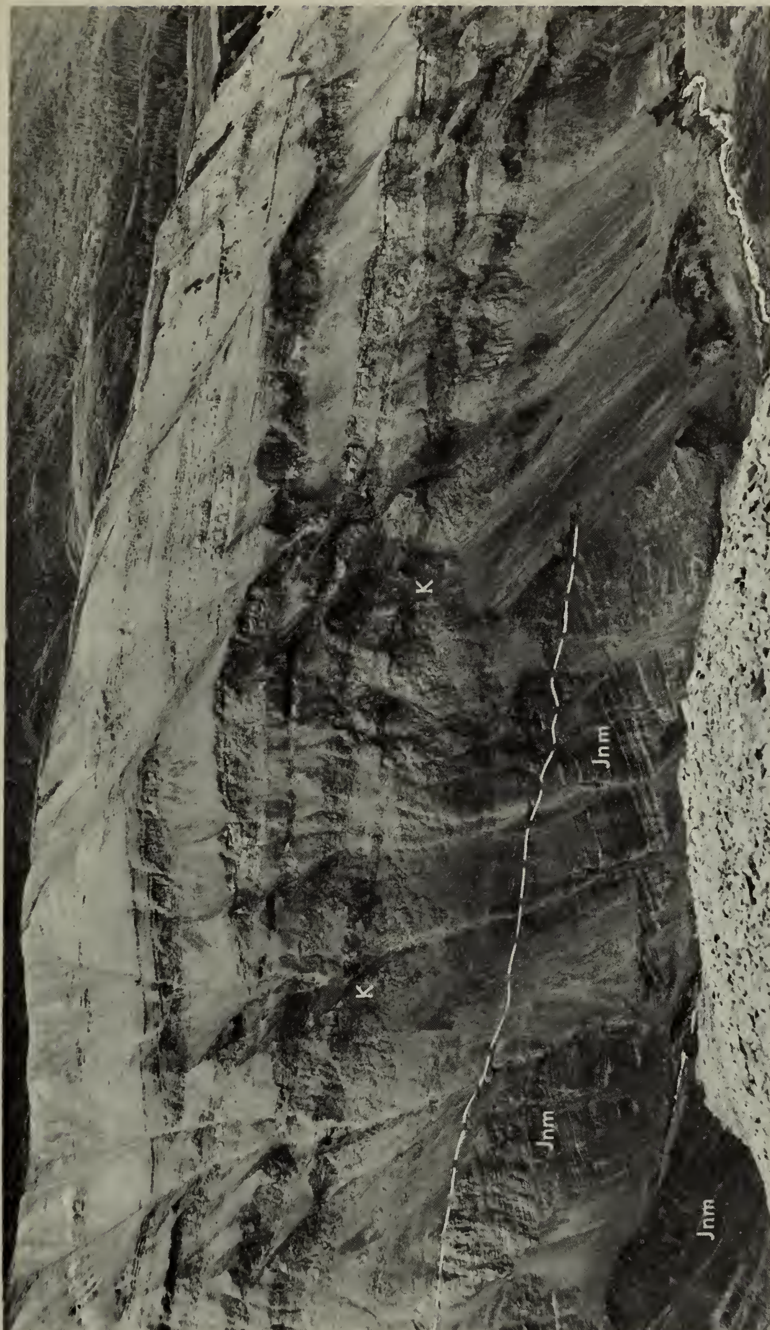


FIGURE 7.—Nizina Mountain Formation (Jnm) unconformably overlain by Cretaceous marine sedimentary rocks (K) at "the amphitheatre." The relief in the photograph is about 600 feet.

Except for one isolated outcrop in the McCarthy C–6 quadrangle (MacKevett, 1965), the Nizina Mountain Formation has been recognized only in the McCarthy C–5 quadrangle.

General character, stratigraphic relations, and thickness

The Nizina Mountain Formation consists dominantly of fine-grained to very fine grained graywacke [1] in distinct beds ½–2 feet thick. Most outcrops of the formation underlie moderate slopes that have reddish-brown weathered surfaces. The formation's upper and lower contacts are unconformities, commonly disconformities, but east of Nizina Mountain its upper contact is an angular unconformity with post-Jurassic rocks (fig. 7). In most places, the Nizina Mountain Formation disconformably overlies the Lubbe Creek Formation (figs. 4, 5, 6), but southeast of Nizina Mountain it disconformably overlies the upper member of the McCarthy Formation. At most places, the Nizina Mountain Formation is overlain disconformably by the Root Glacier Formation (figs. 5, 6). In a few places, it is separated by an angular unconformity from overlying Cretaceous (Albian) sedimentary rocks or from Tertiary rocks that are part of the Wrangell Lava (fig. 7). Quaternary surficial deposits locally cover the Nizina Mountain Formation.

The Nizina Mountain Formation is about 1,350 feet in maximum thickness at its type locality. Elsewhere, because of extensive erosion, it is thinner, and many of its outcrops are only a few tens of a few hundreds of feet thick.

Petrology and petrography

The dominant fine-grained to very fine grained graywackes of the formation are associated with sparsely distributed shaly partings and a few limy lenses and concretions. The graywackes are mainly dark greenish gray and weather reddish brown. They consist of poorly sorted subangular to subrounded clasts in extremely fine-grained chalcedony-rich matrices. The clasts range from 0.05 to 0.5 mm in maximum dimension. They are composed of plagioclase, generally sodic labradorite, and quartz, along with less abundant cherty lithic fragments, calcite, opaque minerals, and rare biotite and chlorite; they also contain clay minerals, opaque dust, and sparse laumontite (leonhardite), epidote, prehnite, and calcite. Opaque minerals in the Nizina Mountain Formation include pyrite, hematite, ilmenite, and magnetite.

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[1] Nomenclature of the sandstones in this report follows the usage of Williams, Turner, and Gilbert (1954, p. 289–321).

Age

The Nizina Mountain Formation is Middle and Late Jurassic and probably includes strata representative of both the Bathonian and Callovian stages. Its large fauna chiefly consists of belemnites that are as much as 5 centimeters long and 0.5 cm wide and of poorly preserved ammonites. Fossils from the formation that were identified by R. W. Imlay (written commun., 1963) include the following: *Parareineckeia* cf. *P. hickersonensis* Imlay, *P.* cf. *P. shelikofana* (Imlay), *P.* sp., *Entolium* sp., *Thracia* sp., *Cobbanites* cf. *C. talkeetnanus* Imlay, *Cranocephalites* cf. *C. costidensus* Imlay, *C.* cf. *C. pompeckji* (Madsen), *Arctocephalites*? sp., *Inoceramus* cf. *I. ambiguus* Eichwald, *Plesiopecten*? sp., *Coelastarte* sp., *Pleuromya* sp., *Liostrea* sp., *Camptonectes* sp., *Oxytoma* sp., *Quenstedtia*? sp., and undetermined belemnites, aptychus, fish scales, and a crustacean appendage.

ROOT GLACIER FORMATION

Name and distribution

The Root Glacier Formation is applied here to the thick dominantly very fine grained and clastic marine sedimentary rocks that are well exposed on the arêtelike ridges that border Root Glacier (Bonanza Ridge in the McCarthy C–5 quadrangle and the ridge that extends northward from Donoho Peak in the McCarthy C–6 quadrangle). Because of structural complications on these ridges, including a thrust fault, the type locality of the Root Glacier Formation is designated as the hillside east of the upper part of McCarthy Creek (fig. 4), where the Root Glacier rocks are also fairly well exposed but less deformed. The formation also includes a facies conglomerate and very coarse grained sandstone.

The Root Glacier Formation extends eastward from the margins of Root Glacier to the slopes southeast of Nizina Mountain (fig. 4). It is well exposed on Bonanza Ridge, the environs of upper McCarthy Creek, the ridge between McCarthy Creek and the West Fork, and near the West Fork Glacier (figs. 4, 5, 8). The conglomerate crops out on the ridge between McCarthy Creek and the West Fork and forms strike-controlled spurs that extend laterally from the main ridge (figs. 4, 8).

The Root Glacier Formation extends northwestward across the McCarthy C–6 quadrangle (MacKevett, 1965) toward the northeast corner of the C–7 quadrangle. The formation has not been recognized in other nearby quadrangles, but it may correlate with some of the Jurassic or Cretaceous rocks of Moffit (1938, p. 66–68) from the Kotsina-Kuskalana region.

General character, stratigraphic relations, and thickness

The formation mainly consists of poorly sorted and poorly bedded pelitic and fine psammitic rocks. Characteristically these rocks form moderately smooth slopes (figs. 5, 8) that locally are breached by a few resistant limy beds and lenses and by outcrops of coarse clastic rocks. The conglomerate forms bold outcrops that protrude from the surrounding rocks (fig. 8). The formation is cut by andesitic dikes that locally are sufficiently numerous to constitute dike swarms and by a few sandstone dikes. Parts of the formation are a series of open folds that commonly plunge gently northwestward.

The Root Glacier Formation disconformably overlies the Nizina Mountain Formation or, locally, the Lubbe Creek Formation (figs. 4, 5, 6). It is overlain unconformably by the Wrangell Lava and in some places is mantled by Quaternary surficial deposits. The conglomerate forms an intraformational lens stratigraphically high in the formation (figs. 4, 5, 8). Both of its contacts are broadly gradational from conglomerate through sandstone to dominantly pelitic rocks. Snow and ice cover parts of the conglomerate.

Accurate estimates of the thickness of the formation are precluded because of the angular unconformity that marks the upper contact, because of the lack of persistent marker beds, and because of numerous folds and faults. The large disparities in estimated thicknesses probably reflect fairly abrupt changes in thickness attributable to such factors as unequal erosion and differences in original thickness. The estimated thicknesses are probably reasonable minimum values. They range from 1,300 to about 4,000 feet. The conglomerate lens is about 200 feet in maximum thickness.

Petrology and petrography

The formation consists mainly of diverse clastic rocks, chiefly mudstone and siltstone and less abundant graywacke, arenite, and shale. It also contains some limy beds, lenses, and concretions. The conglomerate unit comprises well-indurated pebble and cobble conglomerate and coarse-grained and very coarse grained arenite. Reworked shaly chips are constituents of a few of the dominantly pelitic rocks. Most rocks of the formation are dark greenish gray or dark gray where fresh and diverse shades of brown where weathered.

The mudstone, siltstone, and shale contain similar mineral assemblages. They are closely related rocks and are distinguished by the sizes of their clasts or, in the case of the shale, by the development of fissility and pencil structure. Some of the very fine grained rocks contain carbonaceous trash, fossil wood, minute calcitic or chalcedonic spherical remnants of microfossils, and calcite veinlets. The shales and some of the siltstones are finely laminated because of the preferred

FIGURE 8.—Conglomerate (Jrc) of the Root Glacier Formation east of McCarthy Creek. The conglomerate is about 200 feet in maximum thickness. A downfaulted segment of conglomerate is in the left foreground. The Root Glacier Formation (Jr) is cut by several dikes. The Wrangell Lava (QTw) dominates the high terrain in the background.

orientation of their platy minerals or because of the parallelism of trains of carbonaceous material or other rock-forming elements. The mudstone, siltstone, and shale consist of clasts of very fine grained quartz, calcite, and plagioclase, cemented by calcite, along with chlorite and clay minerals. Less common minerals in these rocks are chalcedony, sericite, biotite, illite, and opaque minerals, chiefly pyrite and secondary hydrous iron oxides. The rare detrital constituents are apatite, zircon, and epidote. A few of the mudstones contain moderate quantities of the zeolite, laumontite (leonhardite).

The graywacke and arenite commonly are very fine grained to medium-grained rocks. The graywacke is feldspathic. It characteristically is poorly sorted and is composed of subangular clasts in a calcite-chlorite-clay matrix that constitutes 10–30 percent of the rock. The clasts include quartz and plagioclase and less commonly clinopyroxene, lithic fragments, biotite, hornblende, calcite, K-feldspar, and opaque minerals. The matrix consists chiefly of calcite and chlorite and subordinate amounts of sericite, chalcedony, and clay minerals. The arenite resembles the graywacke, but it either is cemented by calcite or contains less than 10 percent matrix.

The few limy rocks in the formation are chiefly impure calcarenites and represent a phase of sedimentation marked by the dominance of calcite, both in the detrital fraction and in the matrix or cementing material. The concretions form spherical masses ½–1½ feet in diameter that are composed of dense, very fine grained calcite.

The conglomerates contain well-rounded pebbles, cobbles as much as 6 inches in diameter, and a few blocky intraformational fragments of mudstone and siltstone, all in a sandy matrix. About two-thirds of the cobbles and pebbles are limestone, probably derived from the Chitistone and Nizina Limestones. The other cobbles and pebbles include medium-grained granite that is rich in pink K-feldspar, chert, altered basalt derived from the Nikolai Greenstone, and quartz.

Except for a few extraneous lithic pebbles and granules, the very coarse grained and coarse-grained arenite consists of subangular clasts of quartz and plagioclase that are cemented by calcite, along with minor chlorite and clay minerals. It also carries minor amounts of opaque iron minerals and their alteration products. Fragments of wood are widely scattered in some of the sandstone.

Age

Paleontologic studies by R. W. Imlay indicate that the Root Glacier Formation is Late Jurassic or, more specifically, late Oxfordian and Kimmeridgian in age. Its main fossils include pelecypods of the genus *Buchia* [formerly *Aucella*], belemnites as much as 12 cm long, ammonites, and wood fragments. Fossils identified by Imlay include:

Lima sp., *Camptonectes* sp., *Ctenostreon* sp., *Buchia rugosa* (Fischer), *B. concentrica* (Sowerby), *B. mosquensis* (von Buch), *Partschiceras* sp., *Amoeboceras* (*Prionodoceras*) sp., "*Turbo*" sp., and *Cylindroteuthis* sp. This assemblage is similar to that of the Naknek Formation, a widely distributed Upper Jurassic unit of the Alaska Peninsula, Cook Inlet region, and Talkeetna Mountains (Martin, 1926, p. 132, 133, 168–180, 203–218; Grantz, 1960a, b).

THE WEHUTTY FORMATION OF NORTH CAROLINA

By ROBERT M. HERNON [2]

The Wehutty Formation is named for the settlement of Wehutty, southwestern North Carolina, in the north-central part of the Isabella quadrangle, Tennessee and North Carolina.

The mostly poor roads leading northwest and southwest from Mt. Olive church, northeast of the center of the Isabella quadrangle, provide the best and least interrupted exposures of the formation in the Wehutty area. The old State Road through Postell, N.C., has fair exposures of part of the Wehutty, and interrupted exposures may be seen along the tributary Allen Branch road and nearby lumber roads. The upper beds are well exposed along the wagon road of upper Persimmon Creek, southeast of Wolfpen Gap, Isabella quadrangle. The cuts along U.S. Highway 64 and minor tributary roads, southeast of Franklin Gap, Isabella quadrangle, also expose the upper strata.

The Wehutty Formation underlies an irregular area that constitutes aboue one-third of the Isabella quadrangle along its east boundary and also underlies approximately the northwestern third of the adjoining Persimmon Creek quadrangle. The formation extends an unknown distance northeast and southwest of the area studied (Hernon, 1964).

The Wehutty Formation was formerly included in the Copperhill Formation defined by Hurst (1955, p. 9) on the basis of studies in the Mineral Bluff quadrangle, Georgia. He delimited the Copperhill Formation in the northwestern part of the Mineral Bluff quadrangle and regarded the dominantly schistose unit along the southeast margin of its outcrop area as transitional to his Hughes Gap Formation. This schist zone is narrow in the Mineral Bluff quadrangle, but widens rapidly northeastward where it underlies about one-third each of the Isabella and Persimmon Creek quadrangles. Because of the great area extent in these quadrangles and the lithologic differences originally described by Hurst, this schist unit is here separated from the Copperhill Formation and named Wehutty Formation. The transi-

[2] Prepared by Frank S. Simons from rough draft left by Hernon at the time of his death in June 1965.

tional beds of Hurst constitute the upper part of the Wehutty but apparently much of the lower part is cut out in the southern part of the Isabella quadrangle, probably by faulting, and does not extend into the Mineral Bluff quadrangle. Hurst (1955, p. 8–9) considered the Wehutty Formation as part of the Great Smoky Group of the late Precambrian Ocoee Series (King and others, 1958, p. 951).

STRATIGRAPHIC RELATIONS AND THICKNESS

The base of the Wehutty Formation is arbitrarily placed where the available information indicates change from the predominant metasandstone of the Copperhill Formation of Hurst (1955, p. 9) to an alternating sequence in which argillaceous and silty beds are abundant. Other workers would undoubtedly place the contact somewhat higher or lower, but the difference would probably be minor.

The upper contact is clear cut and is placed at the top of a conglomeratic member that can be traced with confidence. This contact corresponds to the base of the Hughes Gap Formation of Hurst (1955, p. 21–35) and marks a change from a sequence to the northwest having dominantly dark schists, locally graphitic, and phyllites to a sequence to the southeast characterized by light-colored sericitic and muscovitic schists.

Folding and probable faulting of this generally incompetent formation make estimates of its thickness uncertain. Its minimum thickness probably exceeds 4,000 feet; the total may be as much as 100 percent greater.

LITHOLOGY

The Wehutty Formation is composed of alternating beds of schist, ranging from fine- to medium-grained phyllitic varieties, and metasandstones, ranging from impure quartzite to metagraywacke. The arenaceous rocks may be pebbly and have thin conglomerate layers. Quartz-pebble conglomerates are conspicuously more common and better sorted in the upper 3,000 feet or so of the formation. The proportion of originally argillaceous and silty sediment is generally about half or more, but some zones hundreds of feet thick are composed largely of metamorphosed sand and gravelly sand.

SCHIST

The Wehutty Formation is distinguished from the underlying Copperhill Formation by a much greater abundance of schist and from the overlying similar Hughes Gap Formation by a greater abundance of light- to dark-gray phyllites and schists.

The schists range in color from light silvery gray to nearly black, and from typical schist to beds that could be described as glossy phyllite, usually with visible porphyroblasts. Schistosity is usually conspicuous, but in some areas and beds the orientation of mineral grains is much less evident macroscopically, particularly where the rock is crowded with garnet or with micaceous minerals in cross position. Some of the dark graphitic layers are slaty in appearance except for warping of the cleavage. Deformation of the schistosity ranges from slight warping to acute crinkling, in places in larger folds.

The minerals of the gray schists are biotite, sericite, plagioclase, quartz, garnet, chlorite, tourmaline, apatite, zircon, opaque matter, and staurolite. Biotite in many beds is of two sizes: small flakes oriented along the schistosity and much larger books in cross position. Biotite is typically brown, but a few small flakes are olive green. Muscovite or sericite is abundant and with biotite defines the schistosity. Plagioclase is a major constituent in some laminae and also occurs infrequently as grains in quartz-rich laminae. It ranges from andesine to sodic oligoclase, but sodic oligoclase is most common. In the thin sections studied, quartz is much more abundant than plagioclase. Garnet is commonly in euhedral crystals with a low percentage of inclusions. Some chlorite is a pale-greenish low-birefringent variety, commonly intimately associated with biotite. A second type of chlorite, in part dusty, is pleochroic from olive or brownish green to colorless or to pale tan or green. The index of its cleavage flakes is near 1.62, and the mineral may be either positive or negative. This type of chlorite is associated closely with staurolite as large masses. It also forms smaller masses, perpendicular to schistosity, that may contain rare uniformly oriented remnants of biotite. Green chlorite, possibly original, forms prominent porphyroblasts in cross position in some biotitic schists.

Tourmaline is in rare olive-green or olive-brown grains. Zircon is in small grains and presumably is the mineral at centers of pleochroic halos in biotite and chlorite. The opaque matter includes iron sulfide, commonly pyrrhotite, dark-gray tabular masses of faintly magnetic iron ore believed to be ilmenite, and dusty to somewhat platy material, part of which is graphite or carbonaceous matter, and the rest of which is unidentified.

Euhedral staurolite is in schist layers an inch to a few inches thick that are interlayered with other schists in the middle and upper part of the formation. Some of the schist is thinly but markedly banded and resembles a unit described by Hurst (1955, p. 17) as varved schist. The staurolite crystals range in length from a fraction of an inch to perhaps 3 inches. Twins are not abundant, and most single crystals are well formed, particularly in finer grained rocks. Staurolite is poikiloblastic in varying degrees. Single crystals may show nearly clear parts and other parts thickly set with inclusions and dark opaque dust, probably graphite. These phases have no constant relation to borders of well-formed crystals and seem to represent differences in replaceability of two or more varieties of schist. Other crystals show rather evenly spaced inclusions throughout, mainly of quartz. Alteration of staurolite to sericite or muscovite is apparently rare except in thin zones along the margins of crystals. The sericite of such zones is in part oriented at high angles to the crystal faces.

METASANDSTONE

The most characteristic metasandstone is micaceous feldspathic quartzite in which biotite predominates over muscovite. Muscovite may nearly equal biotite in some layers but ordinarily is much less abundant and may be present in only trace amounts. The feldspar is sodic oligoclase to medium andesine. Much of it is untwinned and may not show cleavage; a few grains show zoning. In the typical micaceous quartzite, feldspar composes less than 25 percent. Mica, mainly biotite, may be as low as 5 percent, and carbonate commonly ranges from 1 to 8 percent. Other minerals are tourmaline, zircon, sphene, garnet, leucoxene, chlorite, and apatite, in small or trace amounts. Potash feldspar was not found despite careful search. Radioactive material of low birefringence is in part metamict zircon, but other grains may be metamict monazite.

Typical feldspathic quartzite varies toward orthoquartzite by decrease in feldspar or toward graywacke by increase in mica but without showing any content of rock fragments. Thin conglomerate and scattered granules and small pebbles of quartz are other variations of the quartzite.

Some beds of deeply weathered metasandstone are apparently metamorphosed graywacke and arkose like those in the Copperhill Formation. These seem to be scarce, however.

METACONGLOMERATE

Well sorted quartz-pebble conglomerates are common in the upper part of the formation. The pebbles of these conglomerates are rather evenly sized and well rounded, but are flattened by flowage. The matrix shows a large proportion of quartz and lacks the rock fragments of metagraywackes. These conglomerates are interbedded with schists and with feldspathic mica quartzites. Similar conglomerates are also characteristic of, but more abundant in, the overlying Hughes Gap Formation.

Conglomerates in the lower half of the Wehutty commonly show a larger proportion of feldspar pebbles, continous gradation in size of fragment from small pebbles to sand, a lesser degree of rounding, and much less persistence in thickness and extent of individual beds than do the quartz-pebble conglomerates; these conglomerates resemble those of the underlying Copperhill Formation.

REFERENCES CITED

Addicott, W. O., 1967, Age of the Skooner Gulch Formation, Mendocino County, California: U.S. Geol. Survey Bull. 1254–C, 11 p.

Averitt, Paul, 1967, Geologic map of the Kanarraville quadrangle, Iron County, Utah: U.S. Geol. Survey Geol. Quad. Map GQ–694.

Baillie, A. D., 1951, Silurian geology of the Interlake area, Manitoba: Manitoba Dept. Mines and Nat. Resources, Mines Branch Pub. 50–1, 82 p.

Baker, C. L., 1912, Physiography and structure of the western El Paso Range and the southern Sierra Nevada: California Univ., Dept. Geology Bull. 7, p. 117–142.

Baltz, E. H., 1967, Stratigraphy and regional tectonic implications of part of Upper Cretaceous and Tertiary rocks, east-central San Juan Basin, New Mexico: U.S. Geol. Survey Prof. Paper 552, 101 p.

Barnes, Harley, and Christiansen, R. L., 1967, Cambrian and Precambrian rocks of the Groom district, Nevada, southern Great Basin: U.S. Geol. Survey Bull. 1244–G, 34 p.

Bayley, R. W., Dutton, C. E., and Lamey, C. A., 1966, Geology of the Menominee iron-bearing district, Dickinson County, Michigan, and Florence and Marinette Counties, Wisconsin: U.S. Geol. Survey Prof. Paper 513, 96 p.

Behre, C. H., Jr., 1927, Slate in Northampton County, Pennsylvania: Pennsylvania Geol. Survey, 4th ser., Bull. M9, 308 p.

Beikman, H. M., Rau, W. W., and Wagner, H. C., 1967, The Lincoln Creek Formation, Grays Harbor basin, southwestern Washington: U.S. Geol. Survey Bull. 1244–I, 14 p.

Blank, H. R., Jr., and Mackin, J. H., 1967, Geologic interpretation of an aeromagnetic survey of the Iron Springs district, Utah: U.S. Geol. Survey Prof. Paper 516–B, 14 p.

Bowen, O. E., Jr., 1954, Geology and mineral deposits of Barstow quadrangle, San Bernardino County, California: California Div. Mines Bull. 165, p. 1–185.

Brabb, E. E., 1967, Stratigraphy of the Cambrian and Ordovician rocks of east-central Alaska: U.S. Geol. Survey Prof. Paper 559–A, 30 p.

Burk, C. A., 1965, Geology of the Alaska Peninsula—island arc and continental margin: Geol. Soc. America Mem. 99, pt. 1, 250 p.

Campbell, R. H., 1967, Areal geology in the vicinity of the Chariot site, Lisburne Peninsula, northwestern Alaska: U.S. Geol. Survey Prof. Paper 395, 71 p.

Capps, S. R., 1937, Kodiak and adjacent islands, Alaska: U.S. Geol. Survey Bull. 880–C, p. 111–184.

Cashion, W. B., 1967a, Carmel Formation of the Zion Park region, southwestern Utah—A review: U.S. Geol. Survey Bull. 1244–J, 9 p.

——— 1967b, Geology and fuel resources of the Green River Formation, southeastern Uinta Basin, Utah and Colorado: U.S. Geol. Survey Prof. Paper 548, 48 p.

Cater, F. W., and Crowder, D. F., 1967, Geologic map of the Holden quadrangle, Snohomish and Chelan Counties, Washington: U.S. Geol. Survey Geol. Quad. Map GQ–646.

Chidester, A. H., Hatch, N. L., Jr., Osberg, P. H., Norton, S. A., and Hartshorn, J. H., 1967, Geologic map of the Rowe quadrangle, Franklin and Berkshire Counties, Massachusetts, and Bennington and Windham Counties, Vermont: U.S. Geol. Survey Geol. Quad. Map GQ–642.

Chute, N. E., 1966, Geology of the Norwood quadrangle, Norfolk and Suffolk Counties, Massachusetts: U.S. Geol. Survey Bull. 1163–B, 78 p.

Condra, G. E., 1927, The stratigraphy of the Pennsylvanian system in Nebraska: Nebraska Geol. Survey, 2d ser., Bull. 1, 291 p.

——— 1930, Correlation of the Pennsylvanian beds in the Platte and Jones Point sections of Nebraska: Nebraska Geol. Survey, 2d ser., Bull. 3, 57 p.

——— 1935, Geologic cross section, Forest City, Mo., to Du Bois, Nebr.: Nebraska Geol. Survey Paper 8, 23 p.

Condra, G. E., and Reed, E. C., 1937, Correlation of the members of the Shawnee group in southeastern Nebraska and adjacent areas of Iowa, Missouri, and Kansas: Nebraska Geol. Survey, 2d ser., Bull. 11, 64 p.

Cook, E. F., 1960, Great Basin ignimbrites [Nevada-Utah], *in* Geology of east-central Nevada: Intermountain Assoc. Petroleum Geologists Guidebook 11th Ann. Field Conf., p. 134–141.

Creasey, S. C., 1967a, Geologic map of the Benson quadrangle, Cochise and Pima Counties, Arizona: U.S. Geol. Survey Misc. Geol. Inv. Map I–470.

——— 1967b, General geology of the Mammoth quadrangle, Pinal County, Arizona: U.S. Geol. Survey Bull. 1218, 94 p.

Detterman, R. L., and Hartsock, J. K., 1966, Geology of the Iniskin-Tuxedni region, Alaska: U.S. Geol. Survey Prof. Paper 512, 78 p.

Dibblee, T. D., Jr., 1952, Geology of the Saltdale quadrangle, California: California Div. Mines Bull. 160, p. 7–43.

——— 1967a, Areal geology of the western Mojave Desert, California: U.S. Geol. Survey Prof. Paper 522, 153 p.

——— 1967b, Geologic map of the Morongo Valley quadrangle, San Bernardino and Riverside Counties, California: U.S. Geol. Survey Misc. Geol. Inv. Map I–517.

Drake, A. A., Jr., and Epstein, J. B., 1967, The Martinsburg Formation (Middle and Upper Ordovician) in the Delaware Valley, Pennsylvania-New Jersey: U.S. Geol. Survey Bull. 1244–H, 16 p.

Drewes, H. D., 1967, Geology of Connors Pass quadrangle, Schell Creek Range, east-central Nevada: U.S. Geol. Survey Prof. Paper 557, 93 p.

Dutton, C. E., and Linebaugh, R. E., 1967, Map showing Precambrian geology of the Menominee iron-bearing district and vicinity, Michigan and Wisconsin: U.S. Geol. Survey Misc. Geol. Inv. Map I–466.

Easterbrook, D. J., Crandell, D. R., and Leopold, E. B., 1967, Pre-Olympia Pleistocene stratigraphy and chronology in the central Puget Lowland, Washington: Geol. Soc. America Bull., v. 78, no. 1, p. 13–20.

Ekren, E. B., and Frischknecht, F. C., 1967, Geological-geophysical investigations of bedrock in the Island Falls quadrangle, Aroostook and Penobscot Counties, Maine: U.S. Geol. Survey Prof. Paper 527, 36 p.

Ekren, E. B., Rogers, C. L., Anderson, R. E., and Botinelly, Theodore, 1967, Geologic map of the Belted Peak quadrangle, Nye County, Nevada: U.S. Geol. Survey Geol. Quad. Map GQ–606.

Entwistle, L. P., 1944, Manganiferous iron-ore deposits near Silver City, New Mexico: New Mexico School Mines Bull. 19, 70 p.

Epstein, A. G., Epstein, J. B., Spink, W. J., and Jennings, D. S., 1967, Upper Silurian and Lower Devonian stratigraphy of northeastern Pennsylvania, New Jersey, and southeasternmost New York: U.S. Geol. Survey Bull. 1243, 74 p.

Foerste, A. F., 1906, The Silurian, Devonian, and Irvine formations of east-central Kentucky, with an account of their clays and limestones: Kentucky Geol. Survey Bull. 7, 369 p.

Fowler, P. T., 1950, Stratigraphy and structure of the Castleton area, Vermont: Vermont Geol. Survey Bull. 2, 83 p.

Freeman, O. W., 1922, Oil in the Quadrant formation in Montana : Eng. and Mining Jour.-Press, v. 113, no. 19, p. 825–827.

Gallaher, J. A., 1898, Biennial report of the Bureau of Geology and Mines, State of Missouri : Jefferson City, Mo., 68 p.

Gilluly, James, 1967, Geologic map of the Winnemucca quadrangle, Pershing and Humboldt Counties, Nevada: U.S. Geol. Survey Geol. Quad. Map GQ–656.

Goldsmith, Richard, 1967, Bedrock geologic map of the Montville quadrangle, New London County, Connecticut: U.S. Geol. Survey Geol. Quad. Map GQ–609.

Granger, A. E., Bell, M. M., Simmons, G. C., and Lee, Florence, 1957, Geology and mineral resources of Elko County, Nevada : Nevada Bur. Mines Bull. 54, 190 p.

Grant, U. S., 1915, The southeastern coast of Kenai Peninsula, *in* Martin, G. C., Johnson, B. L., and Grant, U. S., Geology and mineral resources of Kenai Peninsula, Alaska : U.S. Geol. Survey Bull. 587, p. 209–238.

Grantz, Arthur, 1960a, Geologic map of Talkeetna Mountains (A–1) quadrangle and the south third of Talkeetna Mountains (B–1) quadrangle, Alaska: U.S. Geol. Survey Misc. Geol. Inv. Map I–314.

——— 1960b, Geologic map of Talkeetna Mountains (A–2) quadrangle, Alaska, and the contiguous area to the north and northwest: U.S. Geol. Survey Misc. Geol. Inv. Map I–313.

Hallgarth, W. E., 1967, Western Colorado, southern Utah, and northwestern New Mexico, Chapter I *in* McKee, E. D., Oriel, S. S., and others, Paleotectonic investigations of the Permian System in the United States: U.S. Geol. Survey Prof. Paper 515, p. 175–197.

Hartshorn, J .H., and Koteff, Carl, 1967, Geologic map of the Springfield South quadrangle, Hampden County, Massachusetts, and Hartford and Tolland Counties, Connecticut: U.S. Geol. Survey Geol. Quad. Map GQ–678.

Hernon, R. M., 1964, Geologic maps and sections of the Ducktown, Isabella, and Persimmon Creek quadrangles, Tennessee and North Carolina : U.S. Geol. Survey open-file report, 3 sheets.

Hitchcock, C. H., 1861, General report upon the geology of Maine: Maine Board Agr. 6th Ann. Rept., p. 146–328.

Hulin, C. D., 1925, Geology and ore deposits of the Randsbury quadrangle, California : California State Mining Bur. Bull. 95, 152 p.

Hurst, V. J., 1955, Stratigraphy, structure, and mineral resources of the Mineral Bluff quadrangle, Georgia : Georgia Geol. Survey Bull. 63, 137 p.

Imlay, R. W., 1967, Twin Creek Limestone (Jurassic) in the western interior of the United States : U.S. Geol. Survey Prof. Paper 540, 105 p.

Imlay, R. W., and Reeside, J. B., 1954, Correlation of the Cretaceous formations of Greenland and Alaska: Geol. Soc. America Bull., v. 65, p. 223–246.

Johnson, W. D., Jr. and Adkison, W .L., 1967, Geology of eastern Shawnee County, Kansas, and vicinity: U.S. Geol. Survey Bull. 1215–A, p. 1–123.

Johnson, W. D., Jr., and Wagner, H. C., 1967, Geology of western Shawnee County, Kansas, and vicinity: U.S. Geol. Survey Bull. 1215–B, p. 125–254.

Jones, D. L., and Detterman, R. L., 1966, Cretaceous stratigraphy of the Kamishak Hills, Alaska Peninsula : U.S. Geol. Survey Prof. Paper 550–D, p. D53–D58.

Jones, W. R., Hernon, R. M., and Moore, S. L., 1967, General geology of Santa Rita quadrangle, Grant County, New Mexica: U.S. Geol. Survey Prof. Paper 555, 144 p.

Ketner, K. B., 1967, West Coast region, Chapter K, *in* McKee, E. D., Oriel, S. S., and others, Paleotectonic investigations of the Permian System in the United States: U.S. Geol. Survey Prof. Paper 515, p. 229–238.

King, P. B., Hadley, J. B., Neuman, R. B., and Hamilton, Warren, 1958, Stratigraphy of Ocoee series, Great Smoky Mountains, Tennessee and North Carolina: Geol. Soc. America Bull., v. 69, no. 8, p. 947–966.

Kirschner, C. E., and Minard, D. L., 1949, Geology of the Iniskin Peninsula, Alaska: U.S. Geol. Survey Oil and Gas Inv. Prelim. Map 95.

Laudon, L. R., and Bowsher, A. L., 1949, Mississippian formations of southwestern New Mexico: Geol. Soc. America Bull., v. 60, no. 1, p. 1–37.

Loney, R. A., 1967, Geologic map of the Hollyhill quadrangle, McCreary and Whitley Counties, Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ–615.

McKee, E. D., 1967, Arizona and western New Mexico, Chapter J *in* McKee, E. D., Oriel, S. S., and others, Paleotectonic investigations of the Permian System in the United States: U.S. Geol. Survey Prof. Paper 515, p. 203–223.

MacKevett, E. M., Jr., 1963, Preliminary geologic map of the McCarthy C–5 quadrangle, Alaska: U.S. Geol. Survey Misc. Geol. Inv. Map I–406.

——— 1965, Preliminary geologic map of the McCarthy C–6 quadrangle, Alaska: U.S. Geol. Survey Misc. Geol. Inv. Map I–444.

MacKevett, E. M., Jr., Berg, H. C., Plafker, George, and Jones, D. L., 1964, Preliminary geologic map of the McCarthy C–4 quadrangle, Alaska: U.S. Geol. Survey Misc. Geol. Inv. Map I–423.

MacKevett, E. M., Jr., and Imlay, R. W., 1962, Jurassic stratigraphy in the McCarthy C–5 quadrangle, Alaska: U.S. Geol. Survey Prof. Paper 450–D, p. D49–D51.

Mackin, J. H., 1960, Structural significance of Tertiary volcanic rocks in southwestern Utah: Am. Jour. Sci., v. 258, no. 2, p. 81–131.

MacNeil, F. S., 1967, Cenozoic pectinids of Alaska, Iceland, and other northern regions: U.S. Geol. Survey Prof. Paper 553, 57 p.

Martin, G. C., 1926, The Mesozoic stratigraphy of Alaska: U.S. Geol. Survey Bull. 776, 493 p.

Mattson, P. H., 1967, Cretaceous and lower Tertiary stratigraphy in west-central Puerto Rico: U.S. Geol. Survey Bull. 1254–B, 35 p.

Maughan, E. K., 1967, Eastern Wyoming, eastern Montana, and the Dakotas, Chapter G *in* McKee, E. D., Oriel, S. S., and others, Paleotectonic investigations of the Permian System in the United States: U.S. Geol. Survey Prof. Paper 515, p. 129–152.

Maughan, E. K., and Roberts, A. E., 1967, Big Snowy and Amsden Groups and the Mississippian-Pennsylvanian boundary in Montana: U.S. Geol. Survey Prof. Paper 554–B, 27 p.

Miller, A. M., 1910, Coals of the lower measures along the western border of the eastern coal field: Kentucky Geol. Survey Bull. 12, 83 p.

——— 1913, Geology of the Georgetown quadrangle [Ky.]: Kentucky Geol. Survey, 4th ser., v. 1, pt. 1, p. 317–351.

Mitchell, G. J., 1922, Geology of the Ponce district, Porto Rico: New York Acad. Sci., Scientific Survey of Porto Rico and the Virgin Islands, v. 1, pt. 3, p. 229–300.

Moffit, F. H., 1938, Geology of the Chitina Valley and adjacent area, Alaska: U.S. Geol. Survey Bull. 894, 137 p.

Monroe, W. H., 1967, Geologic map of the Quebradillas quadrangle, Puerto Rico: U.S. Geol. Survey Misc. Geol. Inv. Map I–498.

Moore, R. C., 1932, A reclassification of the Pennsylvanian system in the northern Midcontinent region: Kansas Geol. Soc. Guidebook 6th Ann. Field Conf., p. 79–98.

——— 1936, Stratigraphic classification of the Pennsylvanian rocks of Kansas: Kansas Geol. Survey Bull. 22, 256 p.

Moore, R. C., Frye, J. C., and Jewett, J. M., 1944, Tabular description of outcropping rocks in Kansas: Kansas State Geol. Survey Bull. 52, pt. 4, p. 127–212.

Muessig, Siegfried, 1967, Geology of the Republic quadrangle and a part of the Aeneas quadrangle, Ferry County, Washington: U.S. Geol. Survey Bull. 1216, 135 p.

Muffler, L. J. P., 1967, Stratigraphy of the Keku Islets and neighboring parts of Kuiu and Kupreanof Islands, southeastern Alaska: U.S. Geol. Survey Bull. 1241–C, 52 p.

Mundorff, M. J., 1967, Ground water in the vicinity of American Falls Reservoir, Idaho; U.S. Geol. Survey Water-Supply Paper 1846, 58 p.

Myers, D. A., 1967, Geologic map of the Torreon quadrangle, Torrance County, New Mexico: U.S. Geol. Survey Geol. Quad. Map GQ–639.

Neuman, R. B., 1967a, Bedrock geology of the Shin Pond and Stacyville quadrangles, Penobscot County, Maine: U.S. Geol. Survey Prof. Paper 524–I, 37 p.

———1967b, Some silicified Middle Ordovician brachiopods from Kentucky: U.S. Geol. Survey Prof. Paper 583–A, 14 p.

Oliver, W. A., Jr., 1967, Stratigraphy of the Bois Blanc Formation in New York: U.S. Geol. Survey Prof. Paper 584–A, 8 p.

Oriel, S. S., Myers, D. A., and Crosby, E. J., 1967, West Texas Permian basin region, Chapter C *in* McKee, E. D., Oriel, S. S., and others, Paleotectonic investigations of the Permian System in the United States: U.S. Geol. Survey Prof. Paper 515, p. 21–60.

Palache, Charles, 1904, Geology about Chichagof Cove: Harriman Alaska Exped., v. 4, p. 69–88.

Pessagno, E. A., Jr., 1960, Geology of the Ponce-Coamo area, Puerto Rico: Commonwealth Puerto Rico Econ. Devel. Adm., Indus. Lab., and Princeton Univ., Dept. Geology, 147 p.

Plafker, George, 1967, Geologic map of the Gulf of Alaska Tertiary province, Alaska: U.S. Geol. Survey Misc. Geol. Inv. Map I–484.

Plafker, George, and MacNeil, F. S., 1966, Stratigraphic significance of Tertiary fossils from the Orca Group in the Prince William Sound region, Alaska: U.S. Geol. Survey Prof. Paper 550–B, p. B62–B68.

Pratt, W. P., 1967, Geology of the Hurley West quadrangle, Grant County, New Mexico: U.S. Geol. Survey Bull. 1241–E, 91 p.

Prinz, W. C., 1967, Geology and ore deposits of the Philipsburg district, Granite County, Montana: U.S. Geol. Survey Bull. 1237, 66 p.

Quinn, A. W., 1967, Bedrock geology of the Chepachet quadrangle, Providence County, Rhode Island: U.S. Geol. Survey Bull. 1241–G, 26 p.

Rickard, L. V., 1962, Late Cayugan (Upper Silurian) and Helderbergian (Lower Devonian) stratigraphy in New York: New York State Mus. and Sci. Service Bull. 386, 157 p.

Roberts, R. J., Hotz, P. E., Gilluly, James, and Ferguson, H. G., 1958, Paleozoic rocks of north-central Nevada: Am. Assoc. Petroleum Geologists Bull., v. 42, no. 12, p. 2813–2857.

Robinson, G. D., 1967, Geologic map of the Toston quadrangle, southwestern Montana: U.S. Geol. Survey Misc. Geol. Inv. Map I–486.

Ross, D. C., 1967, Generalized geologic map of the Inyo Mountains region, California: U.S. Geol. Survey Misc. Geol. Inv. Map. I–506.

Ross, R. J., Jr., 1967, Some Middle Ordovician brachiopods and trilobites from the Basin Ranges, western United States: U.S. Geol. Survey Prof. Paper 523–D, 43 p.

Ruedemann, Rudolf, 1914, Paleozoic rocks of the eastern trough, *in* Ruedemann, Rudolf, and Cushing, H. P., Geology of Saratoga Springs and vicinity: New York State Mus. Bull. 169, p. 66–99.

——— 1942, Cambrian and Ordovician geology of the Catskill quadrangle, *in* Pt. 1 *of* Geology of the Catskill and Kaaterskill quadrangles: New York State Mus. Bull. 331, p. 7–188.

Sainsbury, C. L., 1967, Quaternary geology of western Seward Peninsula, Alaska, *in* Hopkins, D. M., ed., The Bering land bridge: Stanford, Calif., Stanford Univ. Press, p. 121–143.

Sandberg, C. A., 1967, Measured sections of Devonian rocks in northern Wyoming: Wyoming Geol. Survey Bull. 52, 93 p.

Sandberg, C. A., and Klapper, Gilbert, 1967, Stratigraphy, age, and paleotectonic significance of the Cottonwood Canyon Member of the Madison Limestone in Wyoming and Montana: U.S. Geol. Survey Bull. 1251–B, 70 p.

Shride, A. F., 1967, Younger Precambrian geology in southern Arizona: U.S. Geol. Survey Prof. Paper 566, 89 p.

Silberling, N. J., and Wallace, R. E., 1967, Geologic map of the Imlay quadrangle, Pershing County, Nevada: U.S. Geol. Survey Geol. Quad. Map GQ–666.

Simmons, G. C., 1967a, Geologic map of the Clay City quadrangle, Powell and Estill Counties, Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ–663.

——— 1967b, Geologic map of the Richmond North quadrangle, Madison and Fayette Counties, Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ–583.

Skehan, J. W., 1961, The Green Mountain anticlinorium in the vicinity of Wilmington and Woodford, Vermont: Vermont Geol. Survey Bull. 17, 159 p.

Smith, J. H., 1967, Geology of the Wofford quadrangle, Whitley County, Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ–617.

Snyder, G. L., 1967, Bedrock geologic map of the Columbia quadrangle, east-central Connecticut: U.S. Geol. Survey Geol. Quad. Map GQ–592.

Stevenson, F. V., 1944, Devonian of New Mexico [abs.]: Dallas Digest, p. 94–95.

Stoyanow, A. A., 1936, Correlation of Arizona Paleozoic formations: Geol. Soc. America Bull. v. 47, no. 4, p. 459–540.

Tabor, R. W., 1967, Geologic map of the Williamsburg quadrangle, Whitley County, Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ–616.

Theokritoff, George, 1959, Stratigraphy and structure of the Taconic sequence in the Thorn Hill and Granville quadrangles [N.Y.], Pt. 1 *of* Trip G, *in* New England Intercollegiate Geol. Conf. Guidebook, 51st Ann. Mtg., Oct. 1959: p. 53–57.

Treves, S. B., 1960, Geology of the Carney Lake complex, Dickinson County, Michigan [abs.]: Dissert. Abs., v. 20, no. 10, p. 4080–4081.

Ulrich, E. O., 1904, Fossils and age of the Yakutat formation [Alaska]: Harriman Alaska Exped., v. 4, p. 125–146.

Varnes, D. J., and Scott, G. R., 1967, General and engineering geology of the United States Air Force Academy site, Colorado: U.S. Geol. Survey Prof. Paper 551, 93 p.

Vaughan, F. E., 1922, Geology of the San Bernardino Mountains north of San Gorgonio Pass: California Univ. Pub., Dept. Geol. Sci., Bull., v. 13, no. 9, p. 319–411.

Weaver, C. E., 1944, Geology of the Cretaceous (Gualala group) and Tertiary formations along the Pacific Coast between Point Arena and Fort Ross, California: Washington [State] Univ. Pub. in Geology, v. 6, no. 1, 29 p.

Weir, G. W., 1967, Geologic map of the Berea quadrangle, east-central Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ–649.

White, I. C., 1882, The geology of Pike and Monroe Counties: Pennsylvania Geol. Survey, 2d, Rept. G6, 407 p.

Williams, Howel, Turner, F. J., and Gilbert, C. M., 1954, Petrography—an introduction to the study of rocks in thin sections: San Francisco, W. H. Freeman Co., 406 p.

Wilson, R. F., 1967, Whitmore Point, a new member of the Moenave Formation in Utah and Arizona: Plateau, v. 40, no. 1, p. 29–40.

Wilson, R. F., and Stewart, J. H., 1967, Correlation of Upper Triassic and Triassic(?) formations between southwestern Utah and southern Nevada: U.S. Geol. Survey Bull. 1244–D, 20 p.

Zen, E-an, 1961, Stratigraphy and structure at the north end of the Taconic Range in west-central Vermont: Geol. Soc. America Bull., v. 72, no. 2, p. 293–338.

——— 1967, Time and space relationships of the Taconic allochthon and autochthon: Geol. Soc. America Spec. Paper 97, 107 p.

U.S. GOVERNMENT PRINTING OFFICE: 1969 O—323–838