LEGEND

STRATIFIED SEQUENCE (Mainly marine)

Most complete sequences

CENOZOIC — QUATERNARY

- Qh — Holocene
- Qp — Pleistocene. *Glacial deposits not included, see below*
  - (Atlantic and Gulf Coastal Plains and part of Great Plains)
- Limits of Pleistocene glacial deposits. *Solid line, Wisconsin glaciations; broken line, older glaciations. North of these lines, extensive areas of bedrock are concealed* (Northern interior region, Pennsylvania to Montana)

TERTIARY

- Tp — Pliocene
- Tm — Miocene. *Pliocene included in places* (Includes Pliocene in Southeastern U.S.)
- To — Oligocene
- EOCENE (Atlantic and Gulf Coastal Plains):
  - Te_3 — Jackson Group
  - Te_2 — Claiborne Group
  - Te_1 — Wilcox Group
- Tx — Paleocene. *Includes Midway Group of Gulf Coastal Plain*

MESOZOIC — CRETACEOUS

UPPER (Atlantic and Gulf Coastal Plains and western interior region):
- uK_4 — Navarro Group (=Laramie and other formations)
- uK_3, uK_3b, uK_3a — Taylor Group (=Montana Group). *In Montana plains, separated into uK_3a and b at base of Judith River Formation*
- uK_2 — Austin and Eagle Ford Groups (=Colorado Group)
- uK_1 — Woodbine and Tuscaloosa Groups (=Dakota Group). *Lower Cretaceous included in parts of Rocky Mountain and High Plains regions*

LOWER (Texas):
- lK_3 — Washita Group
- lK_2 — Fredericksburg Group
- lK_1 — Trinity Group

JURASSIC
- J — Jurassic
- J$\bar{R}$ — Lower Jurassic and Upper Triassic. *Glen Canyon Group* (Colorado Plateau)

TRIASSIC
- $\bar{R}$ — Triassic. *Mainly marine, but includes continental Dockum Group in Texas and New Mexico, and Newark Group in Appalachian region*

PALEOZOIC — PERMIAN (Midcontinent region (central Texas to Kansas), New Mexico, and northern Arizona. Note-Subdivisions of Guadalupian and Leonardian Series are operational units, which are not necessarily correlative from one area to another; see diagram)
- P_4 — Ochoan Series
- P_3b — Upper part of Guadalupian Series
- P_3a — Lower part of Guadalupian Series
- P_2b — Upper part of Leonardian Series
- P_2a — Lower part of Leonardian Series
- P_1 — Wolfcampian Series

CARBONIFEROUS SYSTEMS (Central interior region, from Appalachians to Kansas and central Texas)

PENNSYLVANIAN
- UPPER: $\mathbb{P}_4$ — Virgilian Series (=Monongahela Group); $\mathbb{P}_3$ — Missourian Series (=Conemaugh Group)
- MIDDLE: $\mathbb{P}_2$ — Des Moinesian Series (=Allegheny Group)
- LOWER: $\mathbb{P}_1$, $\mathbb{P}_1a$ — Atokan and Morrowan Series (=Pottsville Group). *P1a, Jackfork Sandstone of Morrowan age in Ouachita Mountains*

MISSISSIPPIAN
- UPPER: M_3 — Chesterian Series; M_2 — Meramecian Series
- LOWER: M_1 — Osagean and Kinderhookian Series

DEVONIAN (Eastern United States)
- D_3 — Upper Devonian
- D_2 — Middle Devonian
- D_1 — Lower Devonian

SILURIAN
- S_3 — Upper Silurian (Cayugan)
- S_2 — Middle Silurian (Niagaran)
- S_1 — Lower Silurian (Alexandrian)

ORDOVICIAN
- O_3 — Upper Ordovician (Cincinnatian)
- O_2 — Middle Ordovician (Mohawkian). *Upper Ordovician included in places*
- O_1, O_1b, O_1a — Lower Ordovician (Canadian). *In Ozark Plateau of Missouri, divided into O_1a and b at base of Jefferson City Dolomite*

CAMBRIAN
- Є, Єq — Cambrian. *Єq, basal Lower Cambrian clastic rocks, Chilhowee Group and equivalents, shown separately in parts of Appalachian region*

PRECAMBRIAN

Z (800 my to beginning of Cambrian)
- Z — Z sedimentary rocks. *Includes (among other units): In Appalachian region, Ocoee Supergroup and Lynchburg Formation, including rocks older than 800 my; in Lake Superior region, Bayfield Group, Jacobsville and Hinckley Sandstones; in northwestern United States, Windermere Group; in Great Basin, Noonday, Johnnie, and other formations; in Grand Canyon, Chuar Group of Grand Canyon Supergroup*

Y (1600 to 800 my) — BELT SUPERGROUP (Northwestern Montana and northern Idaho)
- Y_3 — Missoula Group
- Y_2 — Wallace, Siyeh, and Helena Formations
- Y_1 — Ravalli Group and Prichard Formation

X (2500 to 1600 my)
- X — X metasedimentary rocks. *Includes (among other units): In Lake Superior region, Animikie Group and Marquette Range Supergroup; in South Dakota and Wyoming units in Black Hills and Medicine Bow Mountains; in Arizona, Mazatzal Quartzite, Yavapai Series, Pinal Schist, and metavolcanic formations. Iron formations of Lake Superior region separately shown in red*

W (2500 my and older)
- W — W metasedimentary rocks. *Includes (among other units): In Lake Superior region, Knife Lake Group; in Montana, Cherry Creek Group; various units in Wyoming*

Combinations

- Q — Quaternary. *Only large areas and thick deposits shown* (Western United States)
- Te — Eocene
- uK — Upper Cretaceous
- lK — Lower Cretaceous
- lMz — Lower Mesozoic
- P_4 — Ochoan Series; P_3 — Guadalupian Series; P_2 — Leonardian Series; P_1 — Wolfcampian Series (West Texas standard)
- P — Permian. *Smaller areas included in undifferentiated upper Paleozoic* (Colorado Plateau and Great Basin)
- $\mathbb{P}$ — Pennsylvanian
- M — Mississippian
- uPz, P, uPzc — Upper Paleozoic. *P, Permian separated in part; uPzc, clastic wedge facies in Nevada and Idaho; Diamond Peak, Wood River, Milligen and associated formations* (Western United States)
- D — Devonian
- DS — Devonian and Silurian
- S — Silurian
- O — Ordovician
- lPz, Є — Lower Paleozoic. *Є, Cambrian separated in part* (Western United States and Piedmont province)
- OЄ — Lower Ordovician and Cambrian carbonate rocks (New York and western New England)
- Y — Y sedimentary rocks. *Includes (among other units): In Lake Superior region, Oronto Group of Keweenawan Supergroup, and Sioux Quartzite; in northwestern United States, undivided Belt Supergroup; in Utah, Big Cottonwood Group; in southwestern United States, Pahrump Group, Unkar Group of Grand Canyon Supergroup, Apache Group and Troy Quartzite; in northern Adirondack Mountains, Grenville Group*

CONTINENTAL DEPOSITS

- Tpc — Pliocene continental deposits. *Includes Miocene and Quaternary deposits in places*
- Tmc — Miocene continental deposits
- Toc — Oligocene continental deposits
- Tec — Eocene continental deposits
- Tel — Eocene lacustrine deposits
- Txc — Paleocene continental deposits
- Kc — Cretaceous continental deposits. *Includes Upper and Lower Cretaceous, depending on locality*
- Jc — Jurassic continental deposits (Minnesota, Iowa, and Michigan)
- P_2ac — Continental deposits of early Leonardian age; P_1c — Continental deposits of Wolfcampian age (Northern Texas, southern Oklahoma, and New Mexico)
- D_3c — Upper Devonian continental deposits; D_2c — Middle Devonian continental deposits (New York, Pennsylvania, and Maine)

EUGEOSYNCLINAL DEPOSITS

- Tmoe — Miocene and Oligocene eugeosynclinal deposits; Toee — Oligocene and Eocene eugeosynclinal deposits; Tee — Eocene eugeosynclinal deposits (Olympic Peninsula, Washington in Olympic Peninsula)
- Ke — Cretaceous eugeosynclinal deposits. *Mainly Upper Cretaceous, some Paleocene and Eocene* (Northwestern California)
- uMze — Upper Mesozoic eugeosynclinal deposits. *Lower Cretaceous to Upper Jurassic, but with uncertain limits; includes Franciscan assemblage of California* (Western California Oregon, and Washington)
- lMze — Lower Mesozoic eugeosynclinal deposits. *Middle and lower Jurassic and Triassic* (Western United States)
- $\bar{R}$Pe — Triassic and Permian eugeosynclinal deposits. *Dominantly volcanic* (Oregon, California and Nevada)
- Pe — Permian eugeosynclinal deposits. *Mostly not separated from undifferentiated upper Paleozoic eugeosynclinal deposits* (Klamath Mountains and Northern Sierra Nevada, California)
- uPze — Upper Paleozoic eugeosynclinal deposits. *Permian separated in a few places: see above* (Western United States)
- Appalachian region: De — Devonian eugeosynclinal deposits; Se — Silurian eugeosynclinal deposits; Oe — Ordovician eugeosynclinal deposits; Єe — Cambrian eugeosynclinal deposits
- New England: DSe — Devonian and Silurian eugeosynclinal deposits; SOe — Silurian and Ordovician eugeosynclinal deposits
- lPze — Lower Paleozoic eugeosynclinal deposits (Western United States)

VOLCANIC ROCKS

- Qv, Qf — Quaternary volcanic rocks. *Qf, Felsic volcanic rocks*
- Tpv, Tpf — Pliocene volcanic rocks. *Tpf, felsic volcanic rocks*
- Tmv, Tmf — Miocene volcanic rocks. *Tmf, Felsic volcanic rocks*
- lTv, lTf — Lower Tertiary volcanic rocks. *Oligocene and Eocene; some Cretaceous included in Arizona and elsewhere. lTf, felsic volcanic rocks in southwestern Colorado and New Mexico*
- uTa — Upper Tertiary andesite; lTa — Lower Tertiary andesite (Cascade Range of Washington and Oregon)
- Teb — Eocene marine pillow basalt (Coast Ranges of Washington and Oregon)
- Kv — Cretaceous volcanic rocks (Montana, Arizona, and New Mexico)
- lMzv — Lower Mesozoic volcanic rocks (Central Nevada, southern Arizona, and New Hampshire)
- $\bar{R}$v — Mafic lava interbedded in Triassic Newark Group (Central Appalachians and New England)
- Appalachian region: Dv — Devonian volcanic rocks; DSv — Devonian and Silurian volcanic rocks; Sv — Silurian volcanic rocks; Ov — Ordovician volcanic rocks; Єv — Cambrian volcanic rocks
- Zv — Z volcanic rocks. *In Appalachian region, Catoctin Greenstone, and related units, including rocks older than 800 my*
- Yv — Y volcanic rocks. *Mafic lavas in Keweenawan Supergroup. Felsic volcanic rocks in Missouri*
- Xv — X volcanic rocks. *Associated with X sedimentary rocks in northern Wisconsin*
- Wv — W volcanic rocks. *Ely Greenstone and other units in Lake Superior region*

PLUTONIC AND INTRUSIVE ROCKS

- Ti — Tertiary intrusive rocks. *Plugs, stocks, and laccoliths of all Tertiary ages; some granite plutons of early to middle Tertiary age*
- Kg_3 — Latest Cretaceous granitic rocks. *Laramide granitic rocks of common usage. Mainly 70 to 80 my, but includes early Tertiary in places* (Arizona, Colorado, and Montana)
- Kg_2 — Upper Cretaceous granitic rocks. *80-90 my*; Kg_1 — Lower Cretaceous granitic rocks. *105-120 my* (Sierra Nevada, California)
- Kg, Kgn — Cretaceous granitic rocks. *Kgn, border gneiss of Idaho batholith* (Western United States)
- Ki — Cretaceous intrusive rocks. *Small plugs and stocks of alkalic rocks* (Arkansas)
- Jg — Jurassic granitic rocks
- $\bar{R}$g — Triassic granitic rocks
- Jmi — Jurassic mafic intrusives (Western Nevada)
- $\bar{R}$i — Triassic mafic intrusives. *In Newark Group* (Appalachian region)
- Units not differentiated as to age:
  - Dikes. *Mainly Triassic in Appalachian region, Precambrian in Minnesota, Tertiary in western United States*
  - um — Ultramafic rocks. *Of Paleozoic age in Appalachian region; of upper Paleozoic and Mesozoic age in western United States; a few of Precambrian age*
- Appalachian region (New England and Piedmont province), rarely in western United States:
  - Pzg_3 — Upper Paleozoic granitic rocks. *About 250-300 my. Mainly in southeast part of Piedmont province, where they are post-metamorphic; rare in New England*
  - Pzg_2 — Middle Paleozoic granitic rocks. *About 350-400 my. In New England, New Hampshire Plutonic Series and others, related to Acadian orogeny; in Piedmont province, synmetamorphic*
  - Pzg_1 — Lower Paleozoic granitic rocks. *About 400-500 my. In New England, Highlandcroft and Oliverian Plutonic Series, related to Taconian orogeny; in Piedmont province premetamorphic*
- Pzmi — Paleozoic mafic intrusives. *Of various ages, not differentiated* (Appalachian region)
- Єg — Cambrian granitic rocks. *About 500 my* (Oklahoma and Colorado)
- Zg — Z granitic rocks. *About 650-800 my*
- Yg_2 — Younger Y granitic rocks. *About 1000 my*
- Yg_1 — Older Y granitic rocks. *About 1300-1400 my*
- Ys — Syenite; Ya — Anorthosite (Adirondack Mountains and elsewhere)
- Ymi — Mafic intrusives. *Includes Duluth Gabbro Complex* (Lake Superior region)
- Xg — X granitic rocks. *About 1700-1800 my*
- Wg — W granitic rocks. *2500 my and older*
- Wmi — W mafic intrusives. *Stillwater Complex of Montana*

METAMORPHIC ROCKS

- Areas of Phanerozoic metamorphism. *Shown by overprint pattern; generally of amphibolite grade or higher, but distinctions are relative. Includes higher grade blueschist metamorphic rocks near west coast*
- cat — Cataclastic rocks. *Produced by Paleozoic orogenies* (Piedmont province)
- ms, m_1, m_2, m_3, m_4 — Metamorphic complexes. *Metamorphosed during Phanerozoic orogenies. Ages of original rocks uncertain; in Piedmont province may be largely Precambrian Z, but with some lower Paleozoic; in northern Washington may be largely lower to upper Paleozoic.* ms, *schist and phyllite*; m_1, *felsic paragneiss and schist*; m_2, *mafic paragneiss (=hornblendite and amphibolite)*; m_3, *migmatite*; m_4, *felsic orthogneiss (=granite gneiss)* (Piedmont province and northern Washington)
- Ym — Paragneiss and schist
- Ygn — Orthogneiss
- Xm — Orthogneiss and paragneiss. *Extensive in western and southwestern United States; of varied compositions and origins*
- Wgn — Orthogneiss and paragneiss

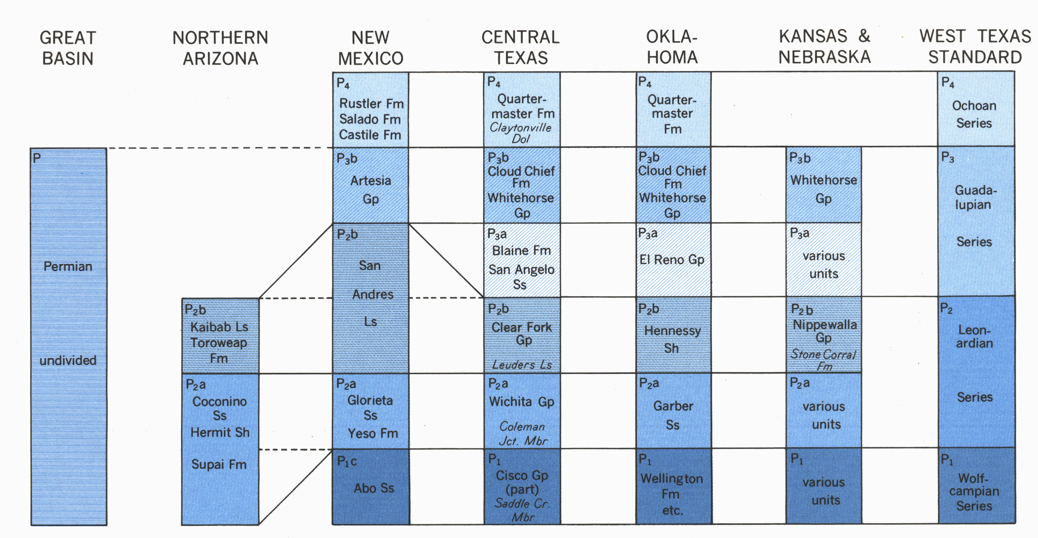

DIAGRAM OF PERMIAN STRATA, NORTHERN ARIZONA TO MIDCONTINENT
[SHOWING UNITS USED ON U.S. MAP]

An Explanatory Text to Accompany the Geologic Map of the United States is published as U.S. Geological Survey Professional Paper 901

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