MAP UNITS

Descriptions in accompanying booklet

SEDIMENTARY ROCK UNITS

QUATERNARY

- Qal — Alluvium
- Qaf — Alluvial fan deposit
- Qlk — Lake deposit
- Qgr — Gravel
- Qtr — Travertine
- Qgd — **Glacial deposits in western and south-central Montana**
- Qgl — Glacial lake deposit

QUATERNARY AND TERTIARY

- QTs — Sediment
- QTps — **Paleosol**
- QTbf — **Basin fill**
- QTgr — Gravel
- QTtu — Tufa
- QTcl — **Clinker**

TERTIARY

- Ts — Sediment or sedimentary rock
- Tsu — Upper Tertiary sediment or sedimentary rock
- Tsm — Middle Tertiary sediment or sedimentary rock
- Tgr — Gravel
- Ttr — Travertine
- Tar — Arikaree Formation
- Tw — Wasatch Formation
- Tk — Kishenehn Formation
- TFu — Fort Union Formation
- TMb — Sentinel Butte Member of Fort Union Formation
- TFr — Tongue River Member of Fort Union Formation
- TFc — Tongue River Member of Fort Union Formation
- TFcl — Cannonball Member of Fort Union Formation
- TFl — Ludlow Member of Fort Union Formation
- TFle — Lebo Member of Fort Union Formation
- TFe — Ekalaka Member of Fort Union Formation
- TFt — Tullock Member of Fort Union Formation

TERTIARY AND CRETACEOUS

- TKfu — Fort Union Formation
- TKb — Beaverhead Group
- TKw — Willow Creek Formation

CRETACEOUS

- Khc — Hell Creek Formation
- Kl — Lance Formation
- KHfh — Hell Creek and Fox Hills Formations
- Kfh — Fox Hills Formation
- Kfc — Colgate Member of Fox Hills Formation
- KTf — Timber Lake and Trail City Members of Fox Hills Formation
- KTc — Trail City Member of Fox Hills Formation
- Kft — Timber Lake Member of Fox Hills Formation
- Kp — Pierre Formation
- Kpg — Groat bed of Pierre Formation
- Kb — Bearpaw Formation
- Kpe — **Judith River through Eagle Formation:** Judith River, Claggett, and Eagle Formations
- Kjc — Judith River and Claggett Formations
- Kjr — Judith River Formation
- Kcl — Claggett Formation
- Kesf — **Eagle through Belle Fourche Formation:** Eagle, Telegraph Creek, Niobrara, Carlile, Greenhorn, and Belle Fourche Formations
- Kga — Gammon Formation
- Kel — Eagle and Telegraph Creek Formations
- Ke — Eagle Formation
- Kls — Landslide Creek Formation
- Kliv — **Livingston Group:** Hoppers, Billman Creek, Miner Creek, and Cokedale Formations
- Kho — Hoppers Formation
- Kbc — Billman Creek Formation
- Kmlc — Miner Creek and Cokedale Formations
- Kle — Lennep Formation

CRETACEOUS (continued)

- Kse — Sedan Formation
- Kmau — Upper Maudlow Formation
- Kmam — Middle Maudlow Formation
- Kmal — Lower Maudlow Formation
- Kevt — Everts Formation
- Kevv — **Everts and Virgelle Formations**
- Kstp — Sphinx Formation
- Kgs — Golden Spike Formation
- Kss — Slim Sam Formation
- Ksm — St. Mary River Formation
- Kh — Horsethief Formation
- Kbmv — Two Medicine and Virgelle Formations
- Kbm — Two Medicine Formation
- Kvt — Virgelle and Telegraph Creek Formations
- Kvl — Virgelle Formation
- Kbsf — **Telegraph Creek through Fall River Formation:** Telegraph Creek, Niobrara, Carlile, Greenhorn, Belle Fourche, Mowry, Thermopolis, and Fall River Formations
- Kbcb — **Telegraph Creek through Belle Fourche Formation:** Telegraph Creek, Niobrara, Carlile, Greenhorn, and Belle Fourche Formations
- Kbca — **Telegraph Creek through Carlile Formation:** Telegraph Creek, Niobrara, and Carlile Formations
- Kbn — Telegraph Creek and Niobrara Formations
- Kbc — Telegraph Creek Formation
- Knbf — **Niobrara through Belle Fourche Formation:** Niobrara, Carlile, Greenhorn, and Belle Fourche Formations
- Kng — **Niobrara through Greenhorn Formation:** Niobrara, Carlile, and Greenhorn Formations
- Kn — Niobrara Formation
- Kca — Carlile Formation
- Kgrb — Greenhorn and Belle Fourche Formations
- Kgr — Greenhorn Formation
- Kbf — **Belle Fourche Formation**
- Kmkf — **Mowry through Fall River Formation:** Mowry, Thermopolis, and Fall River Formations
- Kmt — Mowry and Thermopolis Formations
- Km — Mowry Formation
- Kmm — Telegraph Creek and Marias River Formations
- Kmrk — **Marias River through Kootenai Formation:** Marias River, Blackleaf, and Kootenai Formations
- Kmrb — Marias River and Blackleaf Formations
- Kmr — Marias River Formation
- Kmk — Kevin Member of Marias River Formation
- Kmfc — Ferdig and Cone Members of Marias River Formation
- Kmf — Ferdig Member of Marias River Formation
- Kmcf — Cone and Floweree Members of Marias River Formation
- Kmc — Cone Member of Marias River Formation
- Kmfl — Floweree Member of Marias River Formation
- Kcc — **Carter Creek through Coberly Formation:** Carter Creek, Jens, and Coberly Formations
- Kcof — Cody and Frontier Formations
- Kco — Cody Formation
- Kfb — Frontier and Blackleaf Formations
- Kf — Frontier Formation
- Kmdt — Muddy and Thermopolis Formations
- Kmd — Muddy Formation
- Knc — Newcastle Formation
- Kts — **Thermopolis through Kootenai Formation:** Thermopolis, Fall River, and Kootenai Formations
- Ktf — Thermopolis and Fall River Formations
- Kt — Thermopolis Formation
- Kfr — Fall River Formation
- Kbl — Blackleaf Formation
- Kbbv — Bootlegger and Vaughn Members of Blackleaf Formation
- Kbb — Bootlegger Member of Blackleaf Formation
- Kbv — Vaughn Member of Blackleaf Formation
- Kbf — Taft Hill Member of Blackleaf Formation
- Kbf — Flood Member of Blackleaf Formation
- Kk — Kootenai Formation
- Kku — Upper Kootenai Formation
- Kkm — Middle Kootenai Formation
- Kkl — Lower Kootenai Formation

CRETACEOUS THROUGH TRIASSIC

- K-Tkd — **Kootenai through Dinwoody Formation:** Kootenai, Morrison, Thaynes, Woodside, and Dinwoody Formations

CRETACEOUS AND JURASSIC

- KJbe — **Blackleaf Formation through Ellis Group:** Blackleaf, Kootenai, Mount Pablo, Morrison, Swift, Rierdon, and Sawtooth Formations
- KJkme — **Kootenai Formation through Ellis Group:** Kootenai and Morrison Formations, and Ellis Group
- KJmpa — **Mount Pablo Formation through Ellis Group:** Mount Pablo, Morrison, Swift, Rierdon, and Sawtooth Formations
- KJme — Morrison Formation and Ellis Group

JURASSIC

- Jme — Morrison Formation and Ellis Group
- Jmet — **Morrison through Twin Creek Formation:** Morrison Formation, Ellis Group, and Twin Creek Formation
- Jm — Morrison Formation
- Je — **Ellis Group:** Swift, Rierdon, and Piper or Sawtooth Formations; not all formations present at all locations
- Jsw — Swift Formation
- Jrp — Rierdon and Piper Formations
- Jr — Rierdon Formation
- Jp — Piper Formation

JURASSIC AND TRIASSIC

- JTsrc — **Morrison through Chugwater Formation:** Morrison, Swift, Rierdon, Piper, and Chugwater Formations
- JTsrd — **Morrison through Dinwoody Formation:** Morrison, Swift, Rierdon, Sawtooth, Thaynes, Woodside, and Dinwoody Formations
- JTsc — **Ellis Group through Chugwater Formation:** Swift, Rierdon, Piper, and Chugwater Formations

TRIASSIC

- Tc — Chugwater Formation
- Tpd — **Thaynes through Dinwoody Formation:** Thaynes, Woodside, and Dinwoody Formations
- Twd — Woodside and Dinwoody Formations
- Td — Dinwoody Formation

TRIASSIC AND PERMIAN

- TrPg — Chugwater and Goose Egg Formations

PERMIAN

- Pp — Phosphoria Formation
- Ppp — Phosphoria and Park City Formations
- Psh — Shedhorn Formation

PERMIAN THROUGH MISSISSIPPIAN

- PPMpm — **Phosphoria Formation through Madison Group:** Phosphoria, Quadrant, Amsden, Mission Canyon, and Lodgepole Formations
- PPMpl — **Phosphoria through Lodgepole Formation:** Phosphoria, Quadrant, Amsden, Heath, Otter, Kibbey, Mission Canyon, and Lodgepole Formations
- PPMpb — **Phosphoria Formation through Big Snowy Group:** Phosphoria, Quadrant, and Amsden Formations, and Big Snowy Group
- PPMps — **Phosphoria through Amsden Formation:** Phosphoria, Quadrant, and Amsden Formations
- PPMsa — **Shedhorn through Amsden Formation:** Shedhorn, Quadrant, and Amsden Formations

PERMIAN AND PENNSYLVANIAN

- PPpq — Phosphoria and Quadrant Formations

PENNSYLVANIAN

- Pab — **Alaska Bench Formation:** Locally includes Devils Pocket Formation in central Montana
- Pq — Quadrant Formation
- Pt — Tensleep Formation

PENNSYLVANIAN AND MISSISSIPPIAN

- PMqbs — **Quadrant Formation through Big Snowy Group:** Quadrant and Amsden Formations, and Big Snowy Group; not all formations of Big Snowy Group present at all locations
- PMqa — Quadrant and Amsden Formations
- PMsb — Snaky Canyon and Bluebird Mountain Formations
- PMabs — Amsden Formation and Big Snowy Group
- PMam — **Amsden Group:** Alaska Bench and Tyler Formations
- PMa — Amsden Formation
- PMab — Alaska Bench Formation
- PMt — Tyler Formation
- PMsrm — **Snowcrest Range and Madison Groups; or Snowcrest Range and Tendoy Groups; or Surrett Canyon through McGowan Creek Formation:** Surrett Canyon, South Creek, Scott Peak, Middle Canyon, and McGowan Creek Formations
- PMsrt — **Snowcrest Range and Tendoy Groups:** Conover Ranch, Lombard, Kibbey, McKenzie Canyon, Mission Canyon, and Paine Formations
- PMsr — **Snowcrest Range Group:** Conover Ranch, Lombard, and Kibbey Formations
- PMbs — **Bluebird Mountain through South Creek Formation:** Bluebird Mountain, Railroad Canyon, Surrett Canyon, and South Creek Formations

MISSISSIPPIAN

- Mt — Tyler Formation
- Mbs — **Big Snowy Group:** Heath, Otter, and Kibbey Formations; not all formations present at all locations
- Mh — Heath Formation
- Mok — Otter and Kibbey Formations
- Mo — Otter Formation
- Mk — Kibbey Formation
- Mlm — Lombard Formation and Madison Group
- Msp — Scott Peak Formation
- Mtd — **Tendoy Group:** McKenzie Canyon, Mission Canyon, Middle Canyon, and Paine Formations
- Mmd — Middle Canyon Formation
- Mm — **Madison Group:** Mission Canyon and Lodgepole Formations; or Castle Reef and Allan Mountain Formations
- Mmc — **Mission Canyon Formation:** Locally includes Big Snowy Formation in south-central Montana
- Ml — Lodgepole Formation

MISSISSIPPIAN THROUGH CAMBRIAN

- MDOCft — **Three Forks through Flathead Formation:** Three Forks, Jefferson, Kinnikinic, and Snowy Range Formations, and either Pilgrim, Park, Meagher, Wolsey, and Flathead Formations; or Hasmark, Silver Hill, and Flathead Formations

MISSISSIPPIAN THROUGH ORDOVICIAN

- MDOmk — **Middle Canyon through Kinnikinic Formation:** Middle Canyon, McGowan Creek, Three Forks, Jefferson, and Kinnikinic Formations
- MDOk — **Three Forks through Kinnikinic Formation:** Three Forks, Jefferson, and Kinnikinic Formations
- MDOtb — **Three Forks through Bighorn Formation:** Three Forks, Jefferson, and Bighorn Formations

MISSISSIPPIAN AND DEVONIAN

- MDtm — **Three Forks through Maywood Formation:** Three Forks, Jefferson, and Maywood Formations or Palliser and Alexo Formations, and Fairholme Group in northwestern Montana near Canadian border
- MDtj — Three Forks and Jefferson Formations
- MDt — Three Forks Formation

DEVONIAN

- Dtj — Three Forks and Jefferson Formations
- Dj — Jefferson Formation

DEVONIAN THROUGH CAMBRIAN

- DOCsp — **Jefferson through Snowy Range Formation:** Jefferson, Maywood(?), Beartooth Butte(?), and Snowy Range Formations in Big Snowy Mountains
- DOCsf — **Jefferson through Flathead Formation:** Jefferson, Snowy Range, Pilgrim, Park, Meagher, Wolsey, and Flathead Formations

DEVONIAN AND ORDOVICIAN

- DOjb — **Jefferson and Bighorn Formations:** Locally includes Beartooth Butte Formation in central Montana

ORDOVICIAN

- Ob — **Bighorn Formation**
- Ok — **Kinnikinic Formation**

ORDOVICIAN AND CAMBRIAN

- OCsf — **Bighorn through Flathead Formation:** Bighorn, Pilgrim, Park, Meagher, Wolsey, and Flathead Formations
- OCbf — **Bighorn through Park Formation:** Bighorn, Red Lion, Pilgrim, and Park Formations

CAMBRIAN

- Csrf — **Snowy Range through Flathead Formation:** Snowy Range, Pilgrim, Park, Meagher, Wolsey, and Flathead Formations; or Snowy Range, Hasmark, Silver Hill, and Flathead Formations
- Crl — **Red Lion through Flathead Formation:** Red Lion, Pilgrim, Park, Meagher, Wolsey, and Flathead Formations; or Red Lion, Hasmark, Silver Hill, and Flathead Formations
- Cgf — **Grove Creek through Flathead Formation:** Grove Creek, Snowy Range, Pilgrim, Park, Meagher, Wolsey, and Flathead Formations
- Cdf — **Devils Glen through Flathead Formation:** Devils Glen, Switchback, Steamboat, Pentagon, Pagoda, Dearborn, Damnation or Elko, Gordon, and Flathead Formations
- Csr — Snowy Range Formation
- Cpf — **Pilgrim through Flathead Formation:** Pilgrim, Park, Meagher, Wolsey, and Flathead Formations
- Cpbm — **Pilgrim through Meagher Formation:** Pilgrim, Park, and Meagher Formations
- Cpw — **Pilgrim through Wolsey Formation:** Pilgrim, Park, Meagher, and Wolsey Formations
- Cwf — Wolsey and Flathead Formations
- Cw — Wolsey Formation
- Cf — Flathead Formation

CAMBRIAN, UPPER PROTEROZOIC, OR MIDDLE PROTEROZOIC

- CYq — **Quartzite**

MIDDLE PROTEROZOIC

- Ys — **Metasedimentary rock:** Variously assigned to the Swauger Formation, Yellowjacket Formation, Lemhi Group, and/or Belt Supergroup along southwest Montana-Idaho border
- Yb — Belt Supergroup
- Ymi — **Missoula Group:** Pilcher, Garnet Range, McNamara, Bonner, and Mount Shields Formations; and either Shepard and Snowslip Formations or Shepard Formation and unresolved Snowslip Formation equivalent
- Ygr — **Garnet Range Formation:** Locally includes upper Libby Formation and Pilcher Formation in northwestern Montana
- Ymu — **Upper Missoula Group:** McNamara, Bonner, and Mount Shields Formations; locally includes lower Libby Formation in northwestern Montana
- Ymd — **Lower Missoula Group:** Shepard and Snowslip Formations; or Shepard Formation and unresolved Snowslip Formation equivalent
- Ypg — **Piegan Group:** Helena and Wallace Formations
- Yh — **Helena Formation**
- Yr — **Ravalli Group:** St. Regis, Revett, and Burke Formations; or Empire and Grinnell Formations; or Empire and Spokane Formations
- Ye — Empire Formation
- Ysp — Spokane Formation
- Yg — Greyson Formation
- Ygu — Upper Greyson Formation
- Ygm — Middle Greyson Formation
- Ygl — Lower Greyson Formation
- Yn — Newland Formation
- Ych — Chamberlain Formation
- Yne — Neihart Formation
- Ynla — Newland and LaHood Formations
- Yla — **LaHood Formation:** Locally includes Table Mountain and Moose Formations in Highland Mountains
- Ypu — **Upper Prichard or Appekunny Formation**
- Ypl — Lower Prichard Formation
- Yaw — Altyn and Waterton Formations

IGNEOUS AND METAMORPHIC ROCK UNITS

QUATERNARY

- Qba — Basalt
- Qpr — Plateau Rhyolite
- Qlc — Lava Creek Tuff

QUATERNARY OR TERTIARY

- QTba — Basalt

TERTIARY

- Thr — Huckleberry Ridge Tuff
- Tav — Absaroka Volcanics
- Tlc — **Lowland Creek Volcanics:** Locally includes interfingering Anaconda Conglomerate
- Tv — **Volcanic rock:** Locally includes Challis Volcanics in southwestern Montana
- Tfv — Felsic volcanic rock
- Tmv — Mafic volcanic rock
- Tamb — Andesite and basalt
- Tba — **Basalt:** Includes basalt of several ages in southwestern Montana
- Tda — Dacite
- Tl — Latite
- Tmp — Mafic phonolite
- Tr — Rhyolite
- Tt — Trachyte
- Ti — Intrusive rock
- Tal — **Alkalic intrusive rock**

TERTIARY (continued)

- Tmi — Mafic intrusive rock
- Tgr — Granitic rock
- Td — Diorite
- Tdg — Diorite and gabbro
- Tlp — Lamprophyre
- Tmo — Monzonite
- Tmzd — Monzodiorite
- Tsh — Shonkinite
- Tss — Shonkinite and syenite
- Tsy — Syenite

TERTIARY OR CRETACEOUS

- TKr — Rhyolite
- TKi — Intrusive rock
- TKgr — Granitic rock
- TKdi — Diorite
- TKps — Pyroxenite and syenite
- TKt — Tinguaite
- TKta — Trachyandesite

CRETACEOUS OR MIDDLE PROTEROZOIC

- KYgr — Granitic rock

CRETACEOUS

- Kem — Elkhorn Mountains Volcanics
- Kam — Adel Mountain Volcanics
- Kbr — Sliderock Mountain volcanics
- Kv — Volcanic rock
- Kan — Andesite
- Kad — **Andesite and diorite**
- Kda — Dacite
- Kla — Latite
- Krd — Rhyodacite
- Ki — Intrusive rock
- Kgr — Granitic rock
- Kdi — Diorite
- Kmo — Monzonite
- Kmod — Monzodiorite
- Kpy — Pyroxenite
- Ksh — Shonkinite
- Ksy — Syenite

SILURIAN

- Sgr — Granitic rock

UPPER PROTEROZOIC THROUGH ARCHEAN (age uncertain)

- ZAi — Intrusive rock

UPPER OR MIDDLE PROTEROZOIC

- ZYmi — Mafic intrusive rock

UPPER PROTEROZOIC

- Zdi — Diorite

MIDDLE PROTEROZOIC

- Ypl — Purcell Lava
- Ymi — Mafic intrusive rock
- Yam — Amphibolite
- Yan — Anorthosite
- Yagn — Augen gneiss
- Yqtg — Quartzofeldspathic gneiss

LOWER PROTEROZOIC

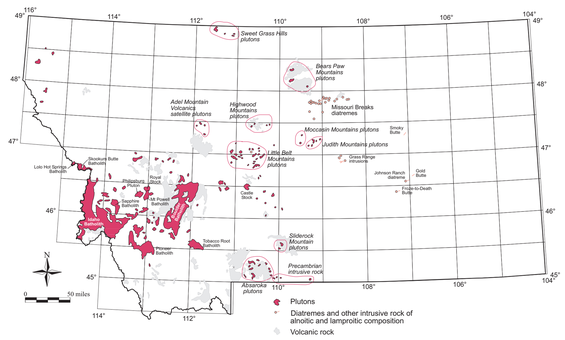
- Xpd — Pinto Diorite
- Xam — Amphibolite
- Xgn — Gneiss and amphibolite
- Xmb — Metabasite
- Xmy — Mylonite
- Xph — Phyllite
- Xq — Quartzite
- Xqfg — Quartzofeldspathic gneiss
- Xs — Schist

LOWER PROTEROZOIC OR ARCHEAN

- XAam — Amphibolite
- XAmy — Mylonite
- XAph — Phyllite
- XAs — Quartzite
- XAqfg — Quartzofeldspathic gneiss
- XAs — Schist
- XAsg — Schist and gneiss
- XAm — Marble

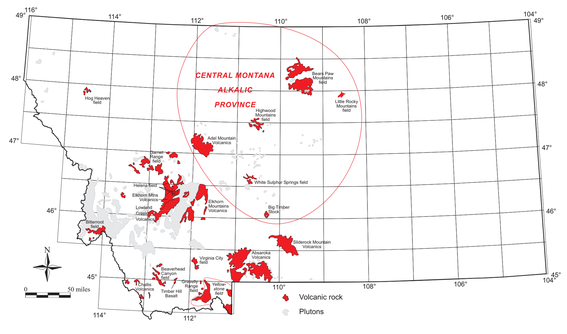
ARCHEAN

- Asw — Stillwater complex
- Ami — Metamorphic rock
- Aum — Ultramafic rock
- Aam — Amphibolite
- Ags — **Gneiss and amphibolite**
- Am — Marble
- Amb — Metabasite
- Amy — Mylonite
- Aq — Quartzite
- Aqam — Quartzite and amphibolite
- Aqfg — Quartzofeldspathic gneiss
- As — Schist
- Asg — Schist and gneiss



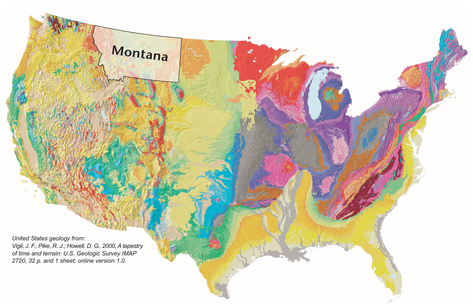
Plutons, diatremes, and other intrusive rock

Compiled from Plate 1, and Hearn and others (1989)



Volcanic rock

Compiled from Plate 1



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Montana Bureau of Mines and Geology

Maps may be obtained from
Publications Office
Montana Bureau of Mines and Geology
1300 West Park Street, Butte, Montana 59701-8997
Phone: (406) 496-4167 Fax: (406) 496-4451
http://www.mbmg.mtech.edu

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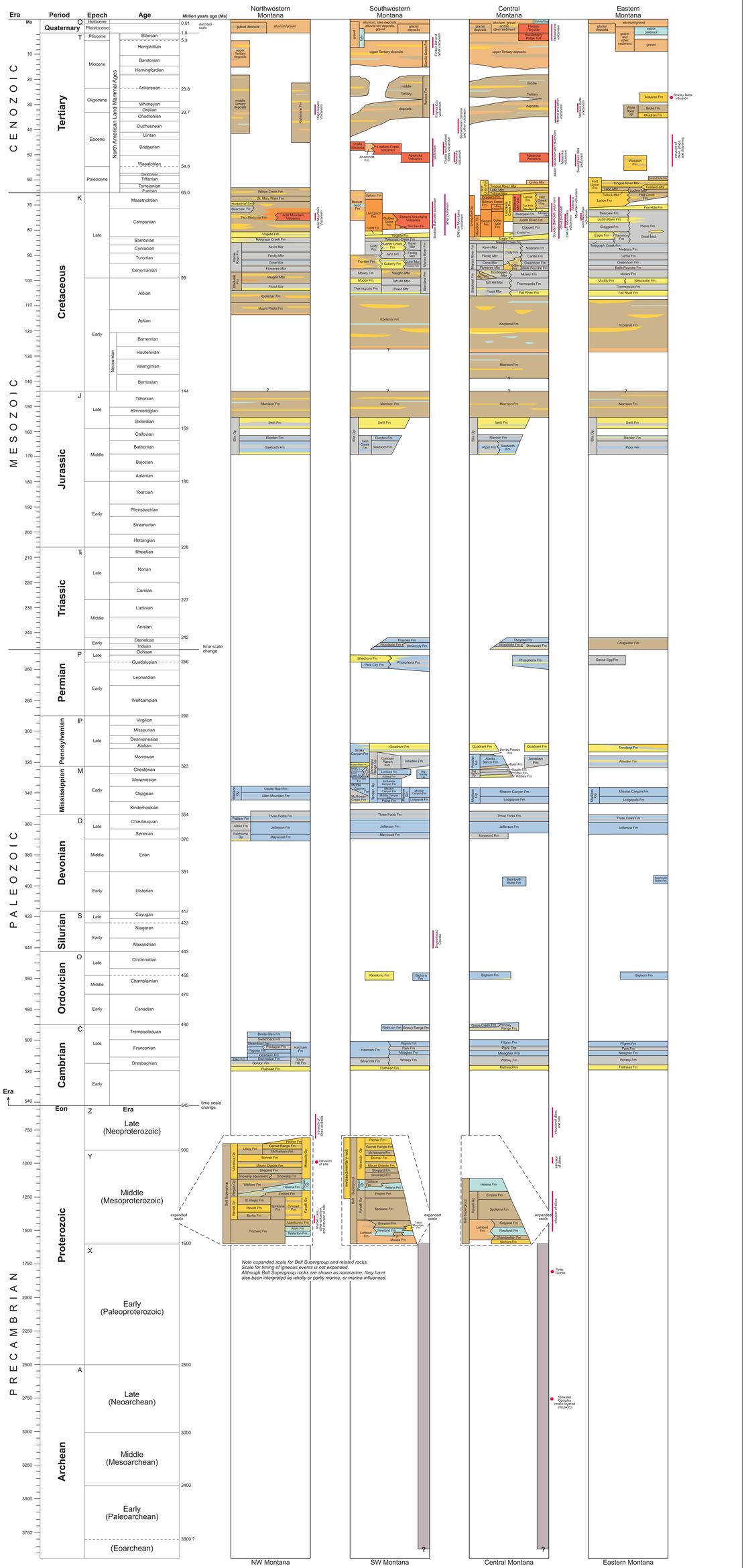
AGE AND CORRELATION OF MAP UNITS

SEDIMENT AND SEDIMENTARY ROCK

Nonmarine
- Gravel, conglomerate, breccia
- Sand, sandstone, quartzite
- Silt, mud, clay; siltstone, mudstone, claystone; sillite, argillite
- Carbonate

Marine
- Sandstone, conglomerate
- Siltstone, mudstone, claystone, shale
- Carbonate

IGNEOUS AND METAMORPHIC ROCK
- Volcanic
- Volcaniclastic
- Precambrian metamorphic