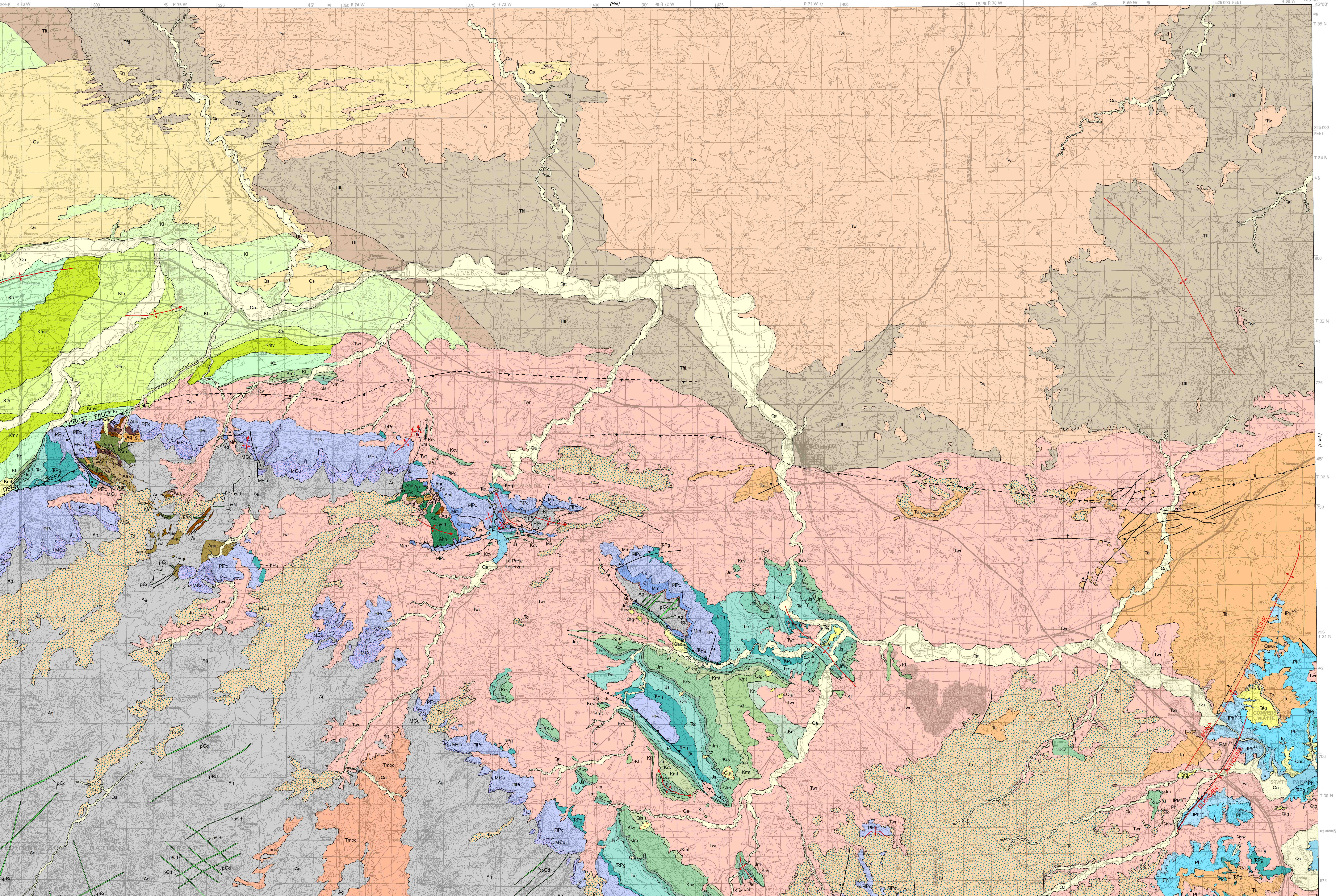
WYOMING STATE GEOLOGICAL SURVEY
Ronald C. Surdam, State Geologist
Laramie Wyoming

Geology - Interpreting the past to provide for the future

Prepared in cooperation with the U.S. GEOLOGICAL SURVEY

MAP SERIES 83
Douglas 1:100,000 - scale Geologic Map



Base map from U.S. Geological Survey 1:100,000 - scale metric topographic map of the Douglas, Wyoming 30' x 60' Quadrangle, 1981

Projection: Universal Transverse Mercator (UTM), zone 13
North American Datum of 1927 (NAD 27)
10,000-meter grid ticks: UTM, zone 13
25,000-foot grid ticks: Wyoming State Plane Coordinate System, east zone

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SCALE 1:100,000
Contour Interval 20 meters

GEOLOGIC MAP OF THE DOUGLAS 30' x 60' QUADRANGLE, CONVERSE AND PLATTE COUNTIES, WYOMING

Compiled and mapped by

J. Fred McLaughlin and Alan J. Ver Ploeg

2008

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Map design and editing by Richard W. Jones

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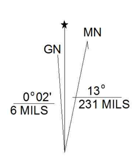
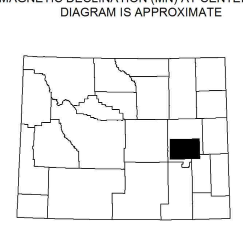
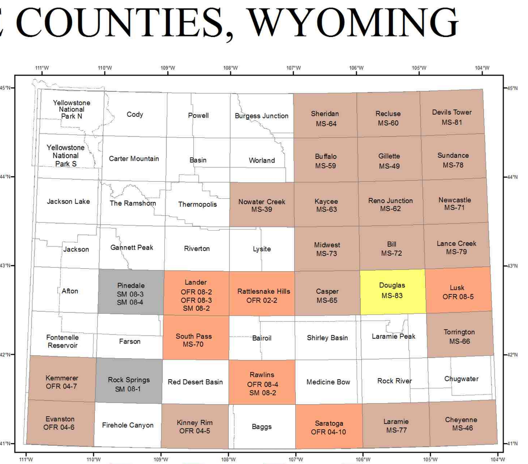


UTM GRID CONVERGENCE (GN)
1981 MAGNETIC DECLINATION (MN) AT CENTER OF SHEET
DIAGRAM IS APPROXIMATE



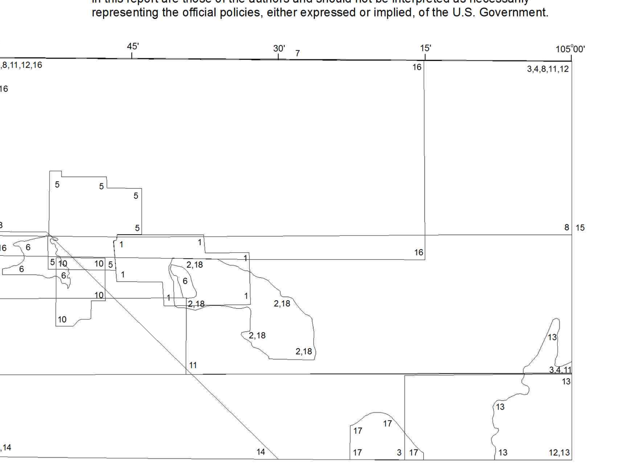
WYOMING QUADRANGLE LOCATION



KEY TO ABBREVIATIONS

Wyoming State Geological Survey maps: Open File Report (OFR), and unpublished STATEMAP project (SM).

INDEX TO 1:100,000-SCALE BEDROCK GEOLOGIC MAPS OF WYOMING



INDEX TO GEOLOGIC MAPPING

(Numbers are those listed in the REFERENCES CITED AND SOURCES OF GEOLOGIC DATA)

REFERENCES CITED AND SOURCES OF GEOLOGIC DATA

(Numbers are those on INDEX TO GEOLOGIC MAPPING)

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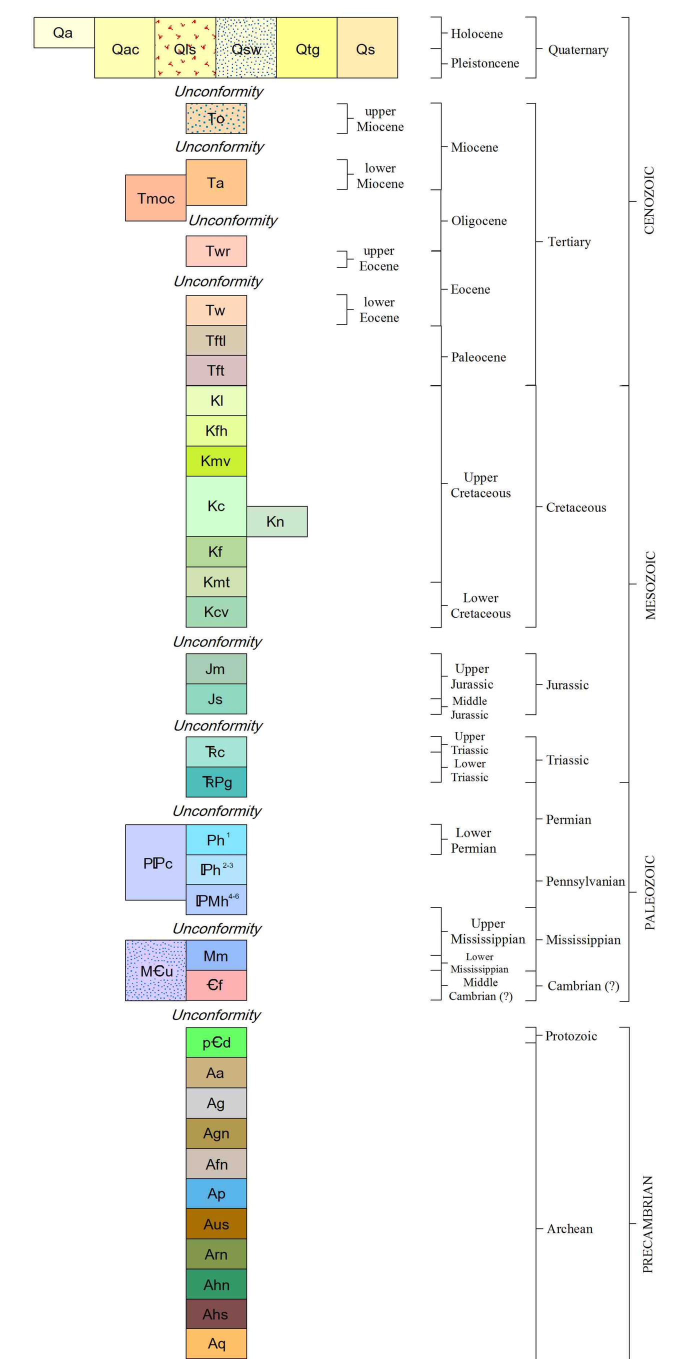
EXPLANATION

CORRELATION OF MAP UNITS



MAP SYMBOLS

Formation contact

Fault— Dashed where approximately located and dotted where concealed; bar and ball on downthrown block; no indication on fault trace indicates undetermined motion

Thrust fault—Dashed where approximately located and dotted where concealed; sawteeth on upthrown block

Anticline—Trace of axial plane and direction of plunge compiled from source mapping or determined by field dip measurements and by photo interpretation. Asymmetric anticlines are shown by shorter arrow on steeper limb

DESCRIPTION OF MAP UNITS

Quaternary surficial deposits

Qa **Alluvial deposits (Holocene)**—Unconsolidated and poorly consolidated clay, silt, sand, and gravel, mainly in channel or meander belt of creeks and rivers. Includes lowest level terrace deposits in many of the stream valleys

Qac **Mixed alluvium and colluvium (Holocene/Pleistocene)**—Sand, silt, clay, and gravel deposited mainly along intermittent streams and rivers; includes slope wash and smaller alluvial fan deposits that coalesce with alluvium and youngest low-level terrace deposits

Qls **Landslide deposits (Holocene/Pleistocene)**—Blocks of bedrock, surficial materials, or loose slope debris that have fallen, slumped, or flowed down moderate to steep slopes, especially those weakened by water and undercutting

Qsw **Slope wash (Holocene/Pleistocene)**—Pebbles, cobble, and gravels amidst a variegated matrix. Result of mass wasting on steep slopes

Qtg **Terrace deposits (Holocene/Pleistocene)**—Unconsolidated (partially consolidated locally) beds of pebble and cobble gravels and lenses of silt and sand. Consist of uncorrelated terraces which occur along present drainages, a few feet (0.6 m) to over 100 feet (30 m) above modern flood plain

Qs **Windblown sand (Holocene/Pleistocene)**—Primarily gray quartz sand; includes active and inactive (stabilized) sand dunes trending southwest to northeast, mainly in the area northeast of Douglas

Tertiary sedimentary rocks

To **Ogallala Formation (upper Miocene)**—Fine- to coarse-grained, light- to greenish-, yellowish-, and orange-gray sandstone interbedded and interfingered in the upper part with conglomerate, claystone, and freshwater limestone; white to dark-gray vitric tuff beds near the top. Lower part has hard "pipy" calcareous sandtone concretions. Thickness 0 to 400 feet (0 to 122 m)

Ta **Arikaree Formation (lower Miocene/Oligocene)**—Light-colored (tan to gray to white), poorly to well cemented, variably tuffaceous siltstone and sandstone interbedded with thin claystone and conglomerate. The formation also contains local limestone and volcanic ash beds. Thickness 0 to 705 feet (0 to 215 m). Only present in the Denver Basin

Tmoc **Miocene and Oligocene conglomerate**—Mostly light-gray conglomerate and gray channel sandstone interbedded with blocky brown and gray claystone and orange-gray siltstone. Claystone is like that underlying White River Formation (Twr). Clasts in the conglomerate are Paleozoic and Precambrian rocks, mostly in a gray calcareous sandstone matrix. Thickness 0 to 490 feet (0 to 150 m)

Twr **White River Group (Oligocene and upper Eocene)**— White to pale-pink blocky tuffaceous, bentonitic claystone and lenticular arkosic conglomerate with lenses of thin gray sandstone. Thickness 0 to 1,150 feet (0 to 350 m). Individual formations (Chadron and Brule) that compose the group elsewhere in eastern Wyoming were not identified or distinguished on this quadrangle. Age of lower part re-assigned to the Eocene based on redefinition of the Oligocene-Eocene boundary (Lillegraven, 1993)

Tw **Wasatch Formation (lower Eocene)**—Lenticular interbeds of gray to light-brown, fine- to coarse-grained, locally conglomeratic, feldspathic to arkosic, cross-bedded sandstone dark- to light-gray or brown or greenish-gray shale, claystone, and siltstone. Subbituminous coal beds, lignite beds, and carbonaceous shales occur locally. Thicknesses of over 2,400 feet (730 m) in the Powder River Basin, but only the lowermost part exposed on this quadrangle (description based on Kohout, 1957)

Fort Union Formation (Paleocene)

Tftl **Tongue River and Lebo Members undivided**—Yellowish-gray sandstone and siltstone; coal beds and carbonaceous shales; and, locally, thin lenses of conglomerate. Thickness ranges from approximately 1,725 to 2,825 feet (525 to 861 m) (Denson and others, 1995)

Tft **Tullock Member**—Distinguished from the conformably overlying Lebo Member by its drab appearance and massive sandstone units. Interbedded tan to buff sandstone, siltstone, dark brown and gray carbonaceous shale, and thin coal beds. Thickness 750 to 1,850 feet (229 to 564 m) (description and thicknesses from Denson and others, 1995)

Upper Cretaceous sedimentary rocks

Kl **Lance Formation**—Gray shale and drab brown, massive lenticular, concretionary sandstone; thin coal beds in lower half. Thickness 1,000 to 2,500 feet (300 to 760 m) (description and thickness modified from Love and others, 1979)

Kfh **Fox Hills Sandstone**—Brownish gray to yellow-brown sandstone interbedded with siltstone and dark sandy shale containing marine fossils. The sandstone is characterized as a coarsening upward sequence. Thickness approximately 150 to 200 feet (45 to 60 m) (description and thickness modified from Love and others, 1979)

Kmv **Mesaverde Formation**—Teapot Sandstone Member, white, at top; underlain by unnamed gray sandstone, shale, and coal member; nonmarine gray Parkman Sandstone Member at base. Parkman Sandstone commonly contains brown-weathering calcareous concretions. Thickness approximately 600 to 1,200 feet (180 to 365 m) (description and thickness from Love and others, 1979)

Kc **Cody Shale**—Dark-gray calcareous, fossiliferous marine shale interbedded with light-gray fine-grained sandstone, with numerous bentonite beds in the upper two-thirds of the formation. Septarian concretions common throughout the shale units. An upper, glauconitic, fine-grained shaly sandstone (Shannon Sandstone Member) occurs about 1,000 feet (300 m) below the top of the formation. The Sussex Sandstone Member occurs approximately 400 feet (120 m) above the Shannon. Thickness approximately 3,000 to 4,500 feet (915 to 1,370 m) (description and thickness from Love and others, 1979)

Kn **Niobrara Formation**—Dark-gray to yellowish-buff marine shale and chalky, soft, white limestone; highly seleniferous. Equivalent to the lower Cody Shale and used in the area 9 miles (km) south of Douglas. Thickness about 700 feet (205 m) (description and thickness modified from Love and others, 1979)

Kf **Frontier Formation**—Dark-gray and black shales with thin concretionary sandstone. Wall Creek Sandstone Member at top. Thickness 590 to 705 feet (180 to 215 m) (description and thickness from Love and others, 1980)

Upper and Lower Cretaceous sedimentary rocks

Kmt **Mowry Shale, Muddy Sandstone, and Thermopolis Shale undivided**

Mowry Shale (Upper Cretaceous)—Hard, dark-gray, siliceous shale that weathers silver gray and contains thin bentonite beds and abundant fish scales. Lower unit is dark-gray to black nonresistant shale with thin interbedded white fine-grained ledge-forming sandstone near the base, grading into the underlying Muddy Sandstone. Contact with overlying Frontier Formation is at the base of the persistent "Clay Spur Bentonite." Thickness approximately 350 feet (107 m) (description and thickness modified from Ver Ploeg, 2004)

Muddy Sandstone (Lower Cretaceous)—Tan to gray, fine- to medium-grained, friable to well-lithified sandstone that is 5 to 30 feet (1.5 to 9 m) thick. Easily identified by its drab color and grains of black minerals (description and thickness modified from Ver Ploeg, 2004)

Thermopolis Shale (Lower Cretaceous)—Dark-gray to black soft fissile shale with some interbedded bentonite layers. Ironstone concretions appear in the lower portion of the formation. Thickness 160 to 200 feet (49 to 60 m) (description and thickness modified from Ver Ploeg, 2004)

Kcv **Cloverly Formation (Lower Cretaceous)**— A tripartite unit consisting of an upper gray to buff to brown, fine- to coarse-grained, resistant slabby sandstone and siltstone, locally referred to as the "Rusty Beds;" variegated buff and purple claystones interbedded with thin black shale beds in the middle; and a basal tan to white, coarse-grained sandstone and chert pebble conglomerate, locally cross-bedded. Thickness approximately 100 to 300 feet (30 to 90 m) (description and thickness modified from Love and others, 1979)

Jurassic sedimentary rocks

Jm **Morrison Formation (Upper Jurassic)**—Pale-green, olive-green, blue-green to maroon and chalky, white, variegated calcareous and bentonitic claystones interbedded with light-gray, fine-grained, friable, cross-bedded silty sandstones. Dinosaur bones and bone fragments are common in the upper part of the section. Thickness approximately 100 to 300 feet (30 to 90 m) (description and thickness modified from Love and others, 1979)

Js **Sundance Formation (Upper and Middle Jurassic)**—Upper part is gray to greenish-gray glauconitic shale with an upper layer consisting of slabby shale and calcareous sandstone that weathers brown and is slightly glauconitic. Middle part is red and gray nonglauconitic sandstone and shale and thin gypsum and limestone beds. Lower part is thick-bedded gray to pink sandstone. Thickness approximately 550 feet (170 m) (description and thickness modified from Love and others, 1979)

Triassic and Permian sedimentary rocks

ℛc **Chugwater Group (Upper and Lower Triassic)**—Includes , from top to bottom, Popo Agie Formation, Crow Mountain Sandstone, Alcova Limestone, and Red Peak Formation. Popo Agie includes lower limestone unit with upper ocher and purple mudstones; Crow Mountain is reddish-orange sandstone, locally referred to as the Jelm Formation; Alcova is purplish gray slabby algal limestone; Red Peak is red shale, siltstone, and fine-grained sandstone. Thickness approximately 300 to 1,000 feet (90 to 305 m) (description and thickness modified from Love and others, 1979)

ℛPg **Goose Egg Formation (Triassic and Permian)**—Dark-red to reddish-orange shale and siltstone with interbedded gypsum, algal limestone, and dolomite, mainly in the lower part. Thickness approximately 200 to 300 feet (60 to 90 m) (description and thickness modified from Love and others, 1979)

Permian, Pennsylvanian, Mississippian, and Cambrian sedimentary rocks

PIPc **Casper Formation (Lower Permian and Upper and Middle Pennsylvanian)**—Alternating thicker red and white sandstone and thinner gray to pink, hard, persistent limestone, with red shale and siltstone. The sandstone is highly cross-bedded with festoon cross-bedding common. The limestone is fossiliferous with brachiopods and fusilinids. Thickness approximately 600 to 1,100 feet (180 to 335 m) (thickness from Love and others, 1979)

Hartville Formation (Permian, Pennsylvanian, and Mississippian)—Subdivided into six divisions, numbered from 1 (stratigraphically highest) to 6 (stratigraphically lowest)

Ph^1 **Hartville Formation, division 1 (Permian)**—Red, silty shale and siltstone, red eolian sandstone, and limestone. Forms ledges and slopes. Thickness 0 to 300 feet (0 to 91 m)

IPh^{2-3} **Hartville Formation, divisions 2 and 3 (Pennsylvanian)**—Interbedded gray limestone, buff to chalky white limestone and dolomite, pink dolomite, buff eolian sandstone, gray, red, and maroon silt and claystones, and thin black shale's. Brachiopods are common in the limestone and dolomite layers. Forms ledged slopes and cliffs. Thickness 0 to 300 feet (0 to 91 m)

$IPMh^{4-6}$ **Hartville Formation, divisions 4, 5, and 6 (Pennsylvanian and Upper Mississippian)**—Hartville 4-5 is interbedded maroon, pink, and gray siltstones and claystones, gray, brown, and buff limestone, pink dolomite, and thin gray sandstones. Forms smooth slopes with limestone ledges. Thickness 0 to 250 feet. Hartville 6 is well indurated maroon to red orthoquartzite. Forms cliffs and rocky knolls. Deposited on a well developed karst surface, and fills sinkholes and caverns in the underlying Madison limestone. Thickness 0 to 120 feet (0 to 37 m)

M€u **Mississippian and Cambrian rocks undivided**—Includes the Madison Limestone (Mississippian) and the Flathead Sandstone (Middle Cambrian) as mapped by Hunter and others (2005) on the adjacent Casper 30?x 60? quadrangle. Sando and Sandberg (1987) assigned rocks in the lower part of the Madison and below to the Englewood Formation (Mississippian and Devonian) and the Fremont Canyon Sandstone (Devonian)

Mm **Madison Limestone (Upper and Lower Mississippian)**—Alternating units of light-tan to gray cherty limestone and dolomite. Upper part bluish-gray limestone with karst surface at the top. Lower part mainly dolomite and dolomitic limestone. The entire formation is fossiliferous; spiriferoid brachiopods and solitary tetracorals being the most common. Sando and Sandberg (1987) included the lowermost part of the Madison Limestone in their Mississippian and Devonian Englewood Formation. Thickness ranges from 100 to 400 feet (30 to 120 m), thinning toward the south (thickness modified from Love and others, 1980)

€f **Flathead Sandstone (Middle Cambrian)**—Reddish-gray, tan, and light-brown, medium- to coarse-grained quartz sandstone in beds, locally conglomeratic and cross-bedded; thin interbeds of green, maroon, and tan siltstone, mainly in the upper part; arkosic conglomerate in the lower part; thickness 15 to 200 feet (5 to 60 m) (description and thickness modified from Gable and others, 1988). This sequence is assigned to the Flathead Sandstone (Middle Cambrian), based on lithologic similarities to the Flathead elsewhere in Wyoming and its stratigraphic position, but Sando and Sandberg (1987) assigned this sequence of rocks to the Englewood Formation (Mississippian and Devonian) and the Fremont Canyon Sandstone (Devonian)

Proterozoic and Archean intrusive rocks

p€d **Diabase dikes**—Fine-to medium-grained, dark-gray to black rock that weathers yellow-brown to brown; dikes are up to 16 feet (5 m) wide and 0.6 mile (1 km) long. Age is uncertain, although they cut Precambrian host rocks. They may be as old as 2,600 Ma (Peterman and Hildreth, 1978), or as young as 740 Ma (Condie, 1976). Description modified from Gable (1987)

Archean intrusive rocks—All descriptions below are modified from those given by Gable (1987)

Aa **Amphibolite**—Medium- to coarse-grained, greenish-gray to black amphibole that varies from poorly foliated to massive; occurs as near vertical dikes 10 feet (3 m) wide, or less, and rarely over a kilometer long. Ages vary, but all crosscut granites

Ag **Granite**— Pinkish-red to bright-red, medium-grained to very coarse-grained, nonfoliated, massive, leucocratic granite of the Laramie batholith; contains a profusion of feldspar-rich pegmatites, some quartz veins, and numerous amphibolite and diabase dikes. Johnson and Hills (1976) reported a Rb/Sr whole-rock age of approximately 2.5 to 2.6 Ga (giga-annum or billions of years before present) for this unit

Agn **Granite gneiss**—Foliated granite: predominantly medium-grained, leucocratic, pinkish-buff rock the weathers brownish gray. Some areas contain sillimanite, garnet, and some microcline megacrysts. Commonly more mafic than local granite (Ag). A Rb/Sr age date of 2,759 ±152 Ma for this unit and 2,776 ±35 Ma for leucogranite in Box Elder Canyon were reported by Johnson and Hills (1976)

Afn **Felsic gneiss**—Gray to grayish-white mottled, fine- to coarse-grained, foliated felsic gneiss; typically weathers buff to pinkish-gray, lighter weathering color corresponds to coarser grained material. Found only in the Spring Canyon area (due west of LaPrele Reservoir) as dikes and small outcrops that crosscut hornblende gneiss (Ahn)

Ap **Pegmatite**—Light colored, very coarse grained rock that varies from feldspar-rich to predominantly quartz; weathers into boulder outcrops. Forms as veins in granite (Ag), in granite gneiss (Agn), and in felsic gneiss (Afn), and as lenses in hornblende gneiss (Ahn)

Aus **Ultramafic rocks including serpentinite**— Generally medium to coarse-grained, dark gray, weathering to dark brown, and commonly altered to serpentinite or to rock containing anthophyllite and cordierite. Occurs as lenses that are as much as 1,600 feet (500 m) long and 820 feet (250 m) wide. Serpentinite is emerald-green to dark greenish-gray, massive to thinly layered criss-crossed by thin veins of magnetite, chromite, and asbestos minerals

Archean layered rocks—All descriptions below, except that for Aq, are modified from those given by Gable (1987)

Arn **Garnet gneiss**—Light colored, garnet-bearing, quartz-feldspar-rich gneiss that is well foliated; varies from fine- to coarse-grained rock; found in the Mormon Canyon and Box Elder Canyon areas (west of Douglas)

Ahn **Hornblende gneiss**—Fine-to medium-grained, salt-and-pepper textured gneiss that is coarser grained than hornblende schist (As). Commonly interlayered with thin layers of hornblende schist (Ahs) and quartzite (Aq)

Ahs **Hornblende schist**—Dark, fine-grained dense, hornblende bearing rock interlayered with light, felsic clinopyroxene rock. Cleaves parallel along closely spaced planar surfaces. Found in the Mormon Canyon area (west of Douglas)

Aq **Quartzite**— White, massive quartzite and felsic matrix quartz- and granite-conglomerate; quartzite includes chert and clastic sandstone; crops out in the upper part of greenstone belt. Description modified from Snyder (1993)

Arq **Garnet quartzite**—Dark-gray to black biotite-garnet-microcline-plagioclase-quartz rock; garnets appear on foliated surfaces. Unit borders large quartzite layer (Aq) in the Spring Canyon area (due west of Laprele Reservoir)

As **Sillimanite-bearing quartz/mica schist**—Medium-gray, thinly foliated, fine-grained sillimanite-quartz-biotite-muscovite schist