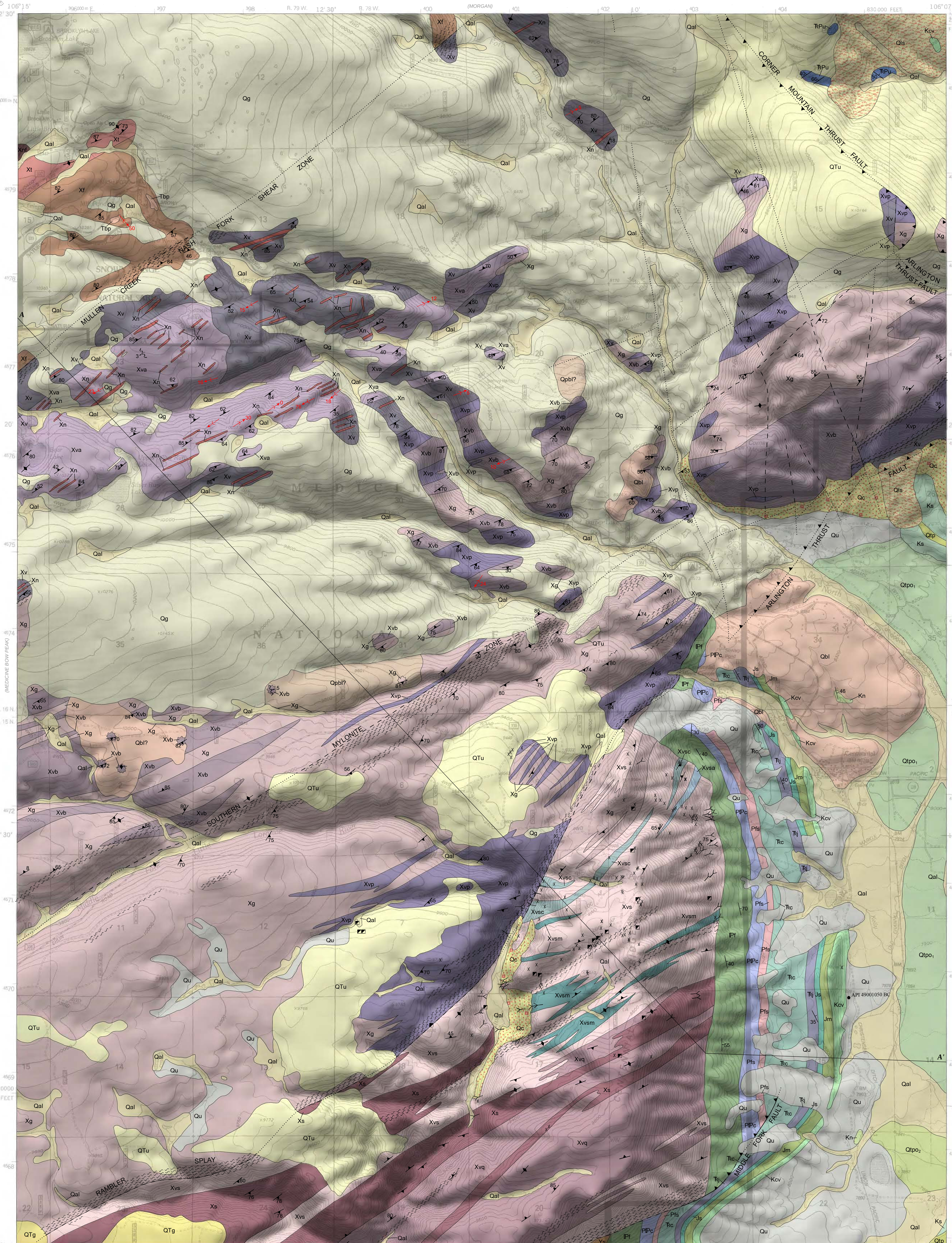
WYOMING STATE GEOLOGICAL SURVEY
Thomas A. Drean, Director and State Geologist
Laramie, Wyoming

Geology - Interpreting the past - providing for the future

OPEN FILE REPORT 13-5
Centennial 1:24,000 - scale
Bedrock Geologic Map



Base map from U.S. Geological Survey 1:24,000-scale topographic map of the Centennial, Wyoming Quadrangle, 1992

Base hillshade derived from USDA/NRCS–National Cartography & Geospatial Center 10-meter Digital Elevation Model (DEM), 2000; azimuth 125°, sun angle 45°, vertical exaggeration 2.0

Projection: Universal Transverse Mercator (UTM), zone 13
North American Datum of 1927 (NAD 27)
1,000-meter grid ticks: UTM, zone 13
10,000-foot grid ticks: Wyoming State Plane Coordinate System, east central zone

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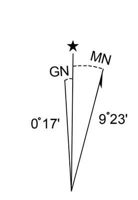
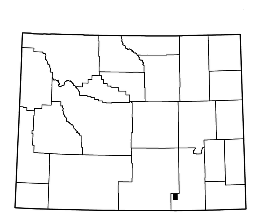
A digital version of this map is available on CD-ROM



UTM GRID AND 2013 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24,000

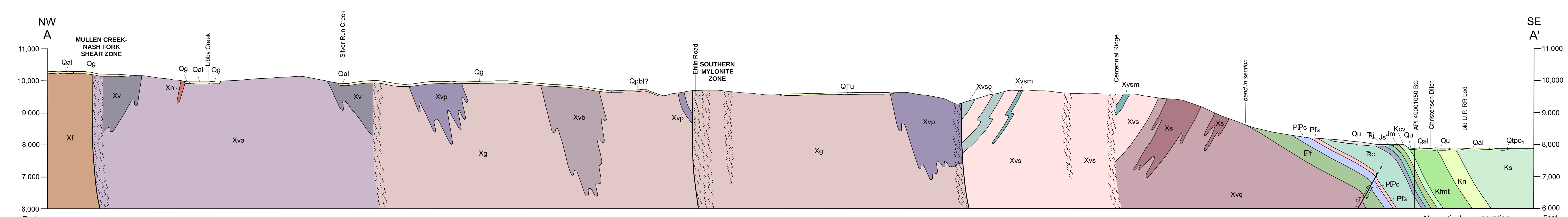
CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929



WYOMING QUADRANGLE LOCATION

Digital cartography by Phyllis Ranz, Joseph F. Johnson and Robin W. Lyons

Map edited by Suzanne C. Luhr and Richard W. Jones



NORTHWEST TO SOUTHEAST CROSS SECTION A-A'

No vertical exaggeration

PRELIMINARY GEOLOGIC MAP OF THE CENTENNIAL QUADRANGLE, ALBANY COUNTY, WYOMING

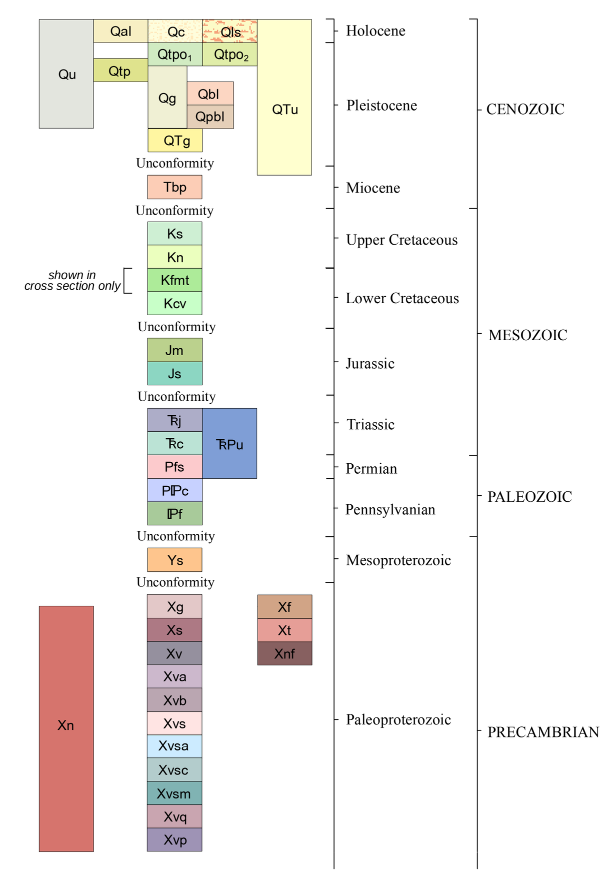
by

Wayne M. Sutherland, James A. Durnan and Joseph F. Johnson

2013

EXPLANATION

CORRELATION OF MAP UNITS



MAP SYMBOLS

Contact

Fault—Dashed where inferred; dotted where concealed; arrows show relative motion on oblique-slip fault

Thrust fault—Solid where certain; dashed where inferred; dotted where concealed; sawteeth on upper (tectonically higher) plate

Shear zone

Strike and dip of bedding

Small fold with plunge

Strike and dip of foliation

Vertical foliation

Small antiform—Trace of axial plane, and angle and direction of plunge

Small synform—Trace of axial plane, and angle and direction of plunge

A —— A' **Line of structural cross section**

Prospect

Adit

Shaft

API 49001050 BC **Drill hole**—Projected to line of cross section

DESCRIPTION OF MAP UNITS

Quaternary

Qal **Alluvium (Holocene)**—Unconsolidated sand, silt, clay, coarse gravels and cobbles, located in and along most drainages; may include eluvial deposits, slope wash and small alluvial and colluvial deposits along drainages

Qc **Colluvium (Holocene)**—Unconsolidated detritus derived from steep slopes or cliffs; includes slope wash, talus, and scree

Qls **Landslide debris (Holocene)**—Locally derived landslide debris from unstable, generally steep slopes

Qtp, $Qtpo_1$, $Qtpo_2$ **Terrace deposits (Pleistocene)**—Boulder, cobble, gravel, sand, and silt-covered terraces and pediment-like surfaces along mountain flanks and drainages **(Qtp)**. Glacial outwash terraces from the North Fork Little Laramie River **($Qtpo_1$)** and glacial outwash terraces from the Middle Fork Little Laramie River **($Qtpo_2$)**, after Blackstone (1969)

Qg **Pinedale glacial deposits undifferentiated (Pleistocene)**—Details of Pinedale glacial deposits are lacking in many areas, but their general extent has been mapped (Houston and others, 1968; Mears, 2001); includes all types of glacial deposits, but is dominated by moraines

Qbl **Bull Lake glacial deposits (Pleistocene)**—Deposits mapped near Centennial, after Mears (2001)

Qpbl **Pre-Bull Lake glacial deposits (Pleistocene)**—Glacial remnant deposits, after Mears (2001)

Qu **Quaternary deposits, undifferentiated**—Quaternary deposits of all types combined where not mapped individually

Quaternary and Tertiary

QTu **Quaternary and? Tertiary deposits undifferentiated**—Deposits may include alluvial, colluvial, terrace, landslide, and glacial, and outcrops of various Tertiary formations

QTg **Upland gravels (Pleistocene and Pliocene?)**—Include upland surfaces veneered with 12 to 61 m (40 to 200 ft) of subrounded to well-rounded quartzite gravel and boulders in the southwest corner of the quadrangle (McCallum, 1964; McCallum and Orback, 1968; and Coalson, 1971); the actual ages of these deposits are unknown

Tertiary

Tbp **Browns Park Formation (Miocene)**—The Browns Park Formation is identified in two small outcrops in the northwestern part of the Centennial quadrangle. The Browns Park is variable in lithology and includes tan, gray, and olive drab calcareous to siliceous sandstone and siltstone, with some thin limestones and white pumicite beds. A loosely consolidated, crossbedded and sandy, ferruginous conglomerate containing Precambrian boulders up to 1 m (3 ft) in diameter is prominent near the base of the formation, 56 km (35 mi) to the northwest in the Saratoga Valley, where the formation exceeds 732 m (2400 ft) in thickness (Montagne, 1991)

Mesozoic

Ks **Steele Shale (Upper Cretaceous)**—Predominantly dark-gray marine shale; upper part is sandy and interbedded with thin, fine-grained buff sandstones; total thickness for the Steele Shale is 793 to 884 m (2600 to 2900 ft) immediately east of the map where a persistent sandstone, 396 m (1300 ft) above the base is locally referred to as the Shannon Sandstone (Blackstone, 1969)

Kn **Niobrara Formation (Upper Cretaceous)**—152 m (500 ft) of highly fossiliferous, predominantly gray, calcareous shale, interbedded with cream to yellow and orange weathered silty limestone (Houston and others, 1968; Blackstone, 1969)

Kfmt **Frontier Formation (Upper Cretaceous), Mowry Shale (Upper Cretaceous), Muddy Sandstone (Lower Cretaceous), and Thermopolis Shale (Lower Cretaceous) undivided**—No outcrops mapped; shown in cross section only. Frontier Formation –3 m-(10 ft)-thick "salt and pepper" Wall Creek Sandstone with chert pebbles on top of 137 m (450 ft) of gray to black shale that hosts septarian concretions in the basal shale. Mowry Shale–46 m (150 ft) of siliceous, silver-gray weathering shale with common fish scales; numerous bentonite layers. Muddy Sandstone–6 m (20 ft) of clean, medium-grained sandstone. Thermopolis Shale–34 m (110 ft) of black to dark-brown marine shale with olive-green sandstone layers (Blackstone, 1969)

Kcv **Cloverly Formation (Lower Cretaceous)**—Distinct white, crossbedded, conglomeratic sandstone at its base overlain by a pink siltstone in the middle, overlain by a rusty to yellow sandstone at the top; total thickness 46 m (150 ft) (Houston and others, 1968; Blackstone, 1969)

Jm **Morrison Formation (Upper Jurassic)**—White sandstone beds near the top underlain by variegated, purple, green, and maroon claystone and shale with abundant green chert; locally hosts fragments of dinosaur bones and calcareous nodules; total thickness 91 m (300 ft) (Houston and others, 1968; Blackstone, 1969)

Js **Sundance Formation (Jurassic)**—About 15 m (50 ft) of white to pale-yellow, crossbedded and ripple-marked calcareous glauconitic sandstone with gray and green shale in the lower part; abundant fossil Pachyteuthis densus (thick-walled belemnite rostrum) found in the upper part (Houston and others, 1968; Blackstone, 1969; Houston and Orback, 1976)

ŦRj **Jelm Formation (Upper Triassic)**—40 to 76 m (130 to 250 ft) of orange and red siltstone and sandstone overlying a distinctive clay-pebble conglomerate, which may include fragments of vertebrate bones and crocodile teeth (Houston and others, 1968; Blackstone, 1969; Love and others, 1993)

Mesozoic and Paleozoic

ŦRc **Chugwater Formation (Triassic and Permian)**—168 m (550 ft) of thinly bedded calcareous red shales, siltstones, and local thin sandstones with some thin beds of limestone and gypsum; lower beds are Permian (Houston and others, 1968; Blackstone, 1969; Houston and Orback, 1976)

ŦRPu **Triassic and Permian Formations undivided**—Jelm, Chugwater, Forelle Limestone, and Satanka Shale, undivided, in small outcrops in the northeast corner of the quadrangle

Paleozoic

Pfs **Forelle Limestone and Satanka Shale (Permian), undivided**—The Forelle Limestone, at the top of the Satanka Shale, is a distinct, resistant 3 to 6 m-(10 to 20 ft)-thick lavender to gray and white, crenulated limestone that often contains thin red to gray shale or siltstone in the middle; the Satanka Shale comprises orange to red siltstones and shales that contain thin lenticular beds of gypsum, limestone, and ferruginous sandstone; total thickness of the Satanka ranges from 37 to 67 m (120 to 220 ft) (Houston and others, 1968; Blackstone, 1969; Houston and Orback, 1976)

PIPc **Casper Formation (Permian and Pennsylvanian)**—63 m (208 ft) thick; made up of an upper yellowish to pink, calcareous, fine- to medium-grained, crossbedded sandstone, a middle hard red and gray siltstone with some thin limestone beds, and a lower white and red crossbedded sandstone (Houston and others, 1968; Blackstone, 1969; Houston and Orback, 1976)

IPf **Fountain Formation (Pennsylvanian)**—122 to more than 152 m (400 to more than 500 ft) of predominantly pink to maroon calcareous arkosic sandstone; contains beds of light-purple arkose, gray sandstone, red siltstone, red shale, and white limestone, with a few interbedded conglomerates (Houston and others, 1968; Blackstone, 1969; Houston and Orback, 1976)

Precambrian

Terminology and unit designations are based on those used by Houston and others (1992) for the Sierra Madre and Medicine Bow Mountains, with details added from numerous other sources listed in the references.

Mesoproterozoic

Ys **Sherman Granite 1415-1435 Ma**—Pink, coarse-grained to pegmatitic microcline granite, dated as 1415-1435 Ma by Aleinikoff (1983) by uranium-lead zircon method (Houston and Karlstrom, 1992)

Paleoproterozoic rocks within or south of the Cheyenne Belt

Xg **Granite and quartz monzonite and related intrusive rocks 1600-1800 Ma**—Includes Houston and Karlstrom's (1992) quartz monzonite gneiss (medium- to coarse-grained, pink to buff to gray gneiss consisting of equal amounts of quartz, potash feldspar, and plagioclase), alaskite, and pink gneissic granite, which forms a gradational contact with migmatitic biotite schist (Xvb)

Xs **Mafic intrusive rocks ~1800 Ma**—Dark-gray to dark-green and black, medium- to coarse-grained, generally sill-like and conformable intrusives having occasional gradational contacts with adjacent rock types; cross-cutting relationships occur locally; complete conversion to amphibolite dominates these rocks, which show moderate to strong northeast-trending gneissic foliation developed by cataclasis in association with the Cheyenne Belt (McCallum, 1968; Houston and Karlstrom, 1992)

Xv **Metavolcanic and metasedimentary rocks**—Encompasses a wide variety of metavolcanic and metasedimentary rocks dominated by mylonitic quartz-feldspar gneiss within the Cheyenne Belt (mapped by Houston and Karlstrom, 1992); mylonitic quartz-feldspar gneiss varies from fine- to medium-grained, sharply defined alternating layers of white to gray quartz-microcline and dark-gray biotite-plagioclase-epidote gneiss, to medium- to coarse-grained, strongly foliated to massive, biotite-quartz-feldspar gneiss, to pink to leucocratic, fine- to medium-grained quartz-feldspar gneiss resembling a weakly metamorphosed alkali-feldspar granite; evidence of mylonitization is present throughout the mylonitic quartz-feldspar gneiss, but interpretation by Duebendorfer(1986) proposes that widespread recrystallization has destroyed much of the mylonitized fabric (Houston and Karlstrom, 1992)

Xva **Mylonitic biotite augen gneiss**—Dark-gray to black, medium-grained, variably mylonitized, moderately to strongly foliated, hornblende-bearing biotite augen gneiss; locally migmatitic with 10-50 percent masses of pegmatite and coarse-grained granitic gneiss that are both concordant and discordant (Houston and Karlstrom, 1992)

Xvb **Migmatitic biotite schist and gneiss**—Encompasses coarse-grained, migmatitic sillimanite-garnet-biotite schist and gneiss and weakly foliated biotite augen gneiss interpreted to be pelitic schist (Xvp) engulfed or intruded by granitic and granodioritic components that comprise 30-70 percent of the unit (Houston and Karlstrom, 1992)

Xvs **Mafic schist and gneiss**—A succession of volcanogenic rocks dominated by moderately to strongly foliated, dark-gray to purple, fine- to medium-grained hornblende-biotite-plagioclase schist and gneiss interlayered with marble, calcite-garnet-diopside-epidote schist, and diopside-hornblende-chlorite-calcite gneiss; also contains conformable amphibolite and felsic gneiss (Houston and Karlstrom, 1992)

Xvsa **Amphibolitized meta-igneous rocks**—Green to black, fine-to coarse-grained rocks dominated by metadiorite and composed chiefly of amphibole and plagioclase (McCallum and Orback, 1968)

Xvsc **Lime-silicate rocks**—Metasedimentary, coarse-grained, weakly to moderately foliated, green to greenish-black, pyroxene-rich, diopside-hornblende-chlorite-calcite gneiss (McCallum and Orback, 1968)

Xvsm **Lime-silicate marble**—Gray to buff, medium- to coarse-grained, strongly layered impure marble containing layers that are calcite-and/or quartz-microcline-rich alternating with layers that are hornblende-plagioclase-quartz-rich; layers vary from less than 1 mm to more than 8 cm (0.04 to more than 3.15 in), and are occasionally enriched in epidote, diopside, and sphene (McCallum and Orback, 1968).

Xvq **Quartz-plagioclase gneiss**—Fine- to medium-grained, pink to gray gneiss with plagioclase, quartz, epidote, and biotite; diverse in composition and is locally mylonitic (Houston and Karlstrom, 1992)

Xvp **Pelitic schist**—Weakly foliated, medium- to coarse-grained, dark-gray to black, biotite-quartz-feldspar schist and gneiss with lesser amounts of fine-grained quartz-biotite schist and gneiss (Houston and Karlstrom, 1992)

Paleoproterozoic rocks north of the Cheyenne Belt

Xn **Mafic intrusive rocks ~1700-2300 Ma**—Dark-gray to black to purple mafic dikes and sills metamorphosed to varying degrees, but with many preserved gabbroic and diabasic textures; smaller dikes and sills are predominantly basalt and diabase; large intrusions tend to be quartz gabbro and norite; Houston and Karlstrom (1992) interpreted many of these mafic intrusions to be emplaced in faults; age range cited is from Houston and others (1992)

Paleoproterozoic Snowy Pass Supergroup

Libby Creek Group – upper part

Xf **French Slate**—610 m (2000 ft) of gray to black slate and phyllite containing beds of hematitic quartzite; alternating layers rich in muscovite, chlorite, and opaque mineral, with layers rich in quartz define laminae that probably represent original bedding; probable marine origin; truncated at top by a major fault (Houston and Karlstrom, 1992)

Xt **Towner Greenstone**—488 m (1600 ft) of massive to schistose, green to purple amphibolite of basaltic composition with local thin beds of quartzite and very fine grained quartzite or metachert; considered to be of marine origin (Houston and Karlstrom, 1992)

Xnf **Nash Fork Formation**—1981 m (6500 ft) of tan siliceous metadolomite accompanied by thick intercalated lenses of black phyllite, and less common thin interlayered beds of quartzite, chert, flat-pebble conglomerate, and iron formation; stromatolitic bioherms characterize the metadolomite and suggest shallow-water marine deposition; the black phyllite is locally graphitic, and in some locations is pyrite- and graphite-rich (Houston and Karlstrom, 1992)

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