WYOMING STATE GEOLOGICAL SURVEY
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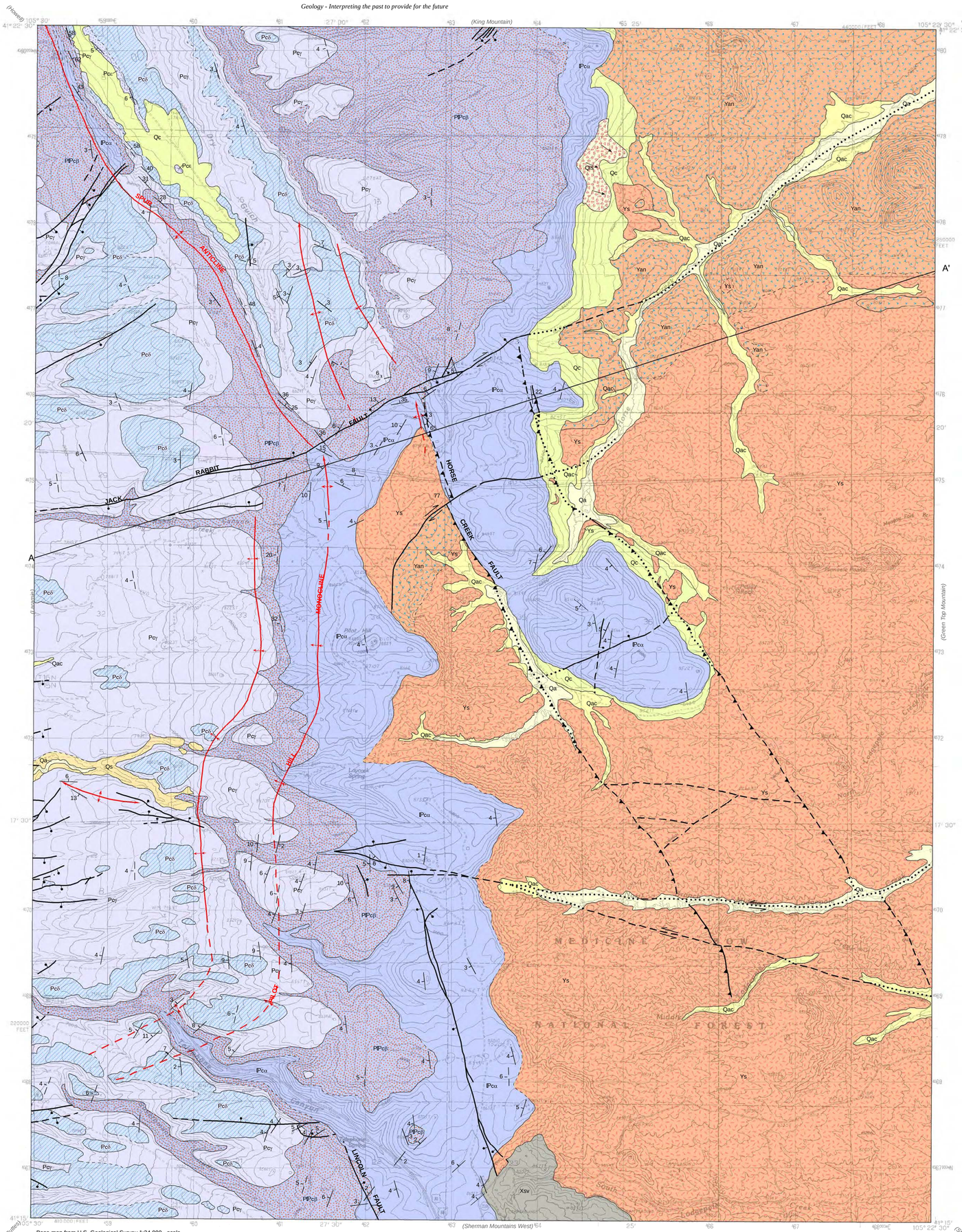
Laramie, Wyoming

Geology - Interpreting the past to provide for the future

Prepared in cooperation with the U.S. GEOLOGICAL SURVEY

MAP SERIES 89
Pilot Hill 1:24,000 - scale Geologic Map
Version 1.0 July 2009



Base map from U.S. Geological Survey 1:24,000 - scale topographic map of the Pilot Hill, Wyoming Quadrangle, 1995.

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

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

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GN MN
0°17' 5 MILS
11°00' 196 MILS
UTM GRID AND 1994 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24,000
1 0.5 0 1 Miles
1,000 0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 Feet
1 0.5 0 1 Kilometers
CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Geology mapped in 1999; revised 2000-2009; members of the Casper Formation were mapped independently using Lundy's (1978) classification scheme (Figure 1) and map as a guide.

Digital cartography by J. Fred McLaughlin and Thomas E. Ver Ploeg

Map editing and design by Richard W. Jones

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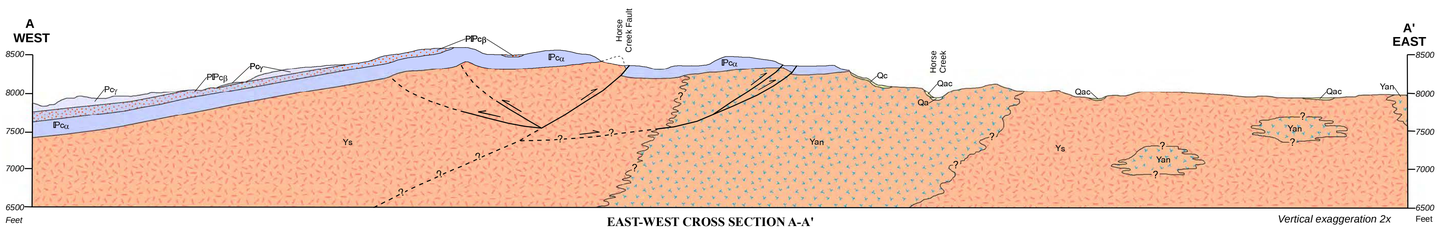


EAST-WEST CROSS SECTION A-A'

Vertical exaggeration 2x

GEOLOGIC MAP OF THE PILOT HILL QUADRANGLE, ALBANY COUNTY, WYOMING

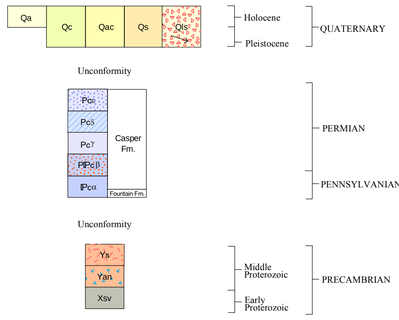
by

Alan J. Ver Ploeg and J. Fred McLaughlin

2009

EXPLANATION

CORRELATION OF MAP UNITS



MAP SYMBOLS

Formation contact—Dashed where approximately located

Fault—Dashed where approximately located, dotted where concealed. Bar and ball on downthrown block; arrows indicate relative direction of oblique-slip movement

Thrust Fault—Dashed where approximately located, dotted where concealed. Sawteeth on upthrown (hanging wall) block

Anticline—Dashed where approximately located; short arrow denotes steeper dipping limb. Trace of axial plane as determined by field measurements and by photo interpretation

Syncline—Dashed where approximately located; arrow on end indicates direction of plunge

Monocline—Dashed where approximately located; short arrow indicates steeper dipping limb. Trace of axial plane as determined by field measurements and by photo interpretation

Strike and dip of beds—Showing angle of dip

Strike and dip measurements from Lundy (1978)

Cross section location

DESCRIPTION OF MAP UNITS

Quaternary surfical deposits

Qa **Alluvial deposits (Holocene)**—Unconsolidated and poorly consolidated clay, silt, sand, and gravel, mainly in flood plains and lowest stream terraces. Thickness approximately 0 to 50 feet (0 to 15 m)

Qc **Colluvium (Holocene/Pleistocene)**—Unconsolidated masses of rock fragments and soil material on relatively steep slopes with thickest accumulations at the bases of slopes.

Qac **Mixed alluvium and colluvium (Holocene/Pleistocene)**—Sand, silt, clay, and gravel deposited mainly along intermittent streams; includes slope wash and smaller alluvial fan deposits that coalesce with alluvium. Thickness approximately 0 to 50 feet (0 to 15 m)

Qs **Windblown sand deposits (Holocene/Pleistocene)**—Active and stabilized dunes, made up of very fine to fine-grained sand sourced by Casper Formation sandstones. Thickness approximately 0 to 15 feet (0 to 4.6 m)

Qls **Landslide deposits (Holocene/Pleistocene)**—Blocks of bedrock or loose slope debris; arrows on the map point in the inferred direction of movement. Many occur in the Alpha member of the Casper Formation, detaching at the contact wit the underlying Precambrian rocks

Paleozoic sedimentary rocks

Casper and Fountain formations, undivided (Permian and Pennsylvanian)—Combined unit not mapped on this quadrangle; see detailed descriptions below. Buff to reddish, calcareous to quartzitic, very fine- to coarse-grained, well-cemented subarkosic sandstone interbedded with buff to purplish-gray limestone and dolomite beds, usually micritic and locally fossiliferous. Sandstone often exhibits large-scale festoon cross-bedding, increasing toward the south. The Casper Formation thins to the south and west as the Fountain Formation increases in thickness. Also, limestone units thin and eventually disappear southward and westward in the Laramie Basin, suggesting a northwest-southeast trending shoreline during deposition. As many as 10 distinct limestone or dolomite beds, which are locally quarried for cement or gravel uses, have been identified in the Casper Formation in the Laramie area (Benniran, 1970). The Casper Formation serves as the prime aquifer for the city of Laramie. Thickness 690 to 735 feet (180 to 210 m) (Benniran, 1970, and Kirn, 1972)

Casper/Fountain subdivisions—Benniran (1970) subdivided the formation into separate informal members based on 10 distinct limestone units (limestone 10 is the highest stratigraphically and the youngest, limestone 1 is the lowest stratigraphically and the oldest) that are separated by sandstones (**Figure 1**). The sandstone units act as local aquifers. Lundy (1978) combined the limestone units into five informal members (epsilon, delta, gamma, beta, and alpha) based upon local, confined aquifer packages (**Figure 1**)

Pcε **Epsilon member (Permian)**—The youngest Casper Formation member; capped by limestone 10 (occurs south of the mapped area) and a sandstone unit that grades into the overlying Satanka Shale. Consists of red to pink, medium- to fine-grained sandstone, mostly covered in the Laramie area to the west. Overall thickness of this member 22 to 30 feet (6.7 to 9.1 m)

Pcδ **Delta member (Permian)**—Includes limestones 9 and 8 and two separate sandstone units. Limestone 9 is an 8- to 10-foot (2.4- to 3.0-m)-thick, white-gray to pink, massive, fractured limestone that caps the member. A reddish-brown to buff, thinly laminated, fine-grained, cross-bedded, subangular to subrounded, 20- to 35-foot (6.1- to 11-m)-thick sandstone separates the two limestones of the delta member. Limestone 8 is a pink to light-gray, massive, fractured 12-foot (3.7-m)-thick limestone that crops out mostly at the base of the Laramie Mountains. A light-tan to red, calcareous, cross-laminated, porous sandstone 40 to 55 feet (12 to 17 m) thick lies beneath limestone 8. Overall thickness of delta member is 80 to 112 feet (24.4 to 34.1 m)

Pcγ **Gamma member (Permian)**—Includes limestones 7 and 6 and two separate sandstone units. Limestone 7 is an extensive unit, 17 to 18 feet (5.2 to 5.5 m) thick, that forms prominent ridges and the main dip slope of the western Laramie Mountains, as well as caps the gamma member. It has a tan to buff, dolomitic base overlain by a sandy grayish limestone. Limestone 6 is a dense, fossiliferous limestone, 6 to 8 feet (1.8 to 2.4 m) thick, that is only present in the northern part of the map area. A pink to red, fine- to medium-grained, friable, calcareous sandstone, 50 to 60 feet (15 to 18 m) thick, extends from the base of limestone 7 to the top of limestone 5 except where it is divided by limestone 6. Overall thickness of gamma member 73 to 86 feet (22 to 26 m)

PPcβ **Beta member (Permian and Pennsylvanian)**—Includes limestones 5 and 4 and two separate sandstone units. Limestone 5 is a finely crystalline, purple to pink, dense, highly fractured limestone, 8 to 12 feet (2.4 to 3.7 m) thick, that weathers to dark gray and caps this member. A light-brown to tan-red, calcareous, fine-grained, friable, 25- to 30-foot (7.6- to 9.1-m)-thick sandstone separates limestones 5 and 4. Limestone 4 has a buff to tan dolomitic base that grades upward into light-gray to purple, dense, ridge-forming limestone, 18 to 26 feet (5.5 to 7.9 m) thick. Below limestone 4, a thick [90 feet (30 m)], red to buff, moderately resistive, extremely calcareous, thick, moderately sorted sandstone layer forms the base of the beta member. North of Rogers Canyon (on adjacent quadrangles) entire member is Permian in age. Overall thickness of this member 141 to 158 feet (43.0 to 48.2 m)

IPcα **Alpha member (Pennsylvanian)**—The oldest member of the Casper Formation includes limestones 3, 2, and 1 and three separate sandstone units, the lowest of which grades into the underlying Fountain Formation, which forms the base of this member. Limestone 3 at the top of the alpha member is one of the more prominent limestones in this section of the Casper Formation. The base of the 29- to 40-foot (8.8- to 12-m)-thick limestone 3 is light-tan to brown sandy dolomite, fining upwards into a purple-pink carbonate that weathers gray and forms ridges. A light-brown to reddish-brown, poorly sorted, fine-grained sandstone unit, 75 to 80 feet (23 to 24 m) thick, separates limestone 3 from limestone 2. Limestone 2 is a thin [8 to 12 feet (2.4 to 3.7 m)], pink to purple, sandy unit that is mostly covered in the map area. A pink to brown, calcareous, cross-laminated, medium-sorted, fine-grained sandstone, 65 to 80 feet (20 to 24 m) thick, separates limestones 2 and 1. Limestone 1 is a purple to pink, massive, fossiliferous, sandy unit, 9 to 13 feet (2.7 to 4.0 m) thick. The unit below limestone 1 is a tan, pink, and red, cross-bedded, medium-grained sandstone that interfingers with thin [up to 1inch (3 cm)] thick, sandy limestones. The basal sandstone unit, 80 to 150 feet (24 to 46 m) thick, is slightly arkosic; more so as it grades into the Fountain Formation. Overall thickness of the alpha member 266 to 375 feet (81.1 to 114 m)

Fountain Formation (Pennsylvanian)--Coarse-grained pink to red to purple sandstone and arkose, with some conglomerates, siltstones and shales. Interfingers with and underlies Casper Formation, thinning to the north and pinching out near Rogers Canyon. For mapping purposes, the Fountain Formation was included with the alpha member. The Fountain Formation lies unconformably on top of Precambrian basement rock. Possibly deposited by an alluvial plain or a series of coalescing fans at the base of the Ancestral Rockies. Approximately 30 feet (9 m) thick at Pilot Hill (Benniran, 1970)

Middle Proterozoic granitic and metamorphic rocks

Ys **Sherman Granite**— Medium- to coarse-grained, pink to orange, biotite hornblende granite, syenogranite, quartz monzonite, and granodiorite; gradational with or interfingers with the syenite of the Laramie Mountains. The Sherman Granite has been dated at 1,430 +20 Ma (Mega-annum or million years before present) by a Rb-Sr whole rock isochron (Zielinski and others, 1981)

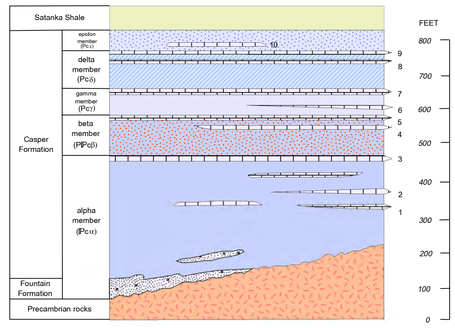
Yan **Laramie Mountains anorthosite and norite**—White to light bluish gray, medium- to coarse-grained, generally leucocratic anorthosite that is massive to layered to brecciated. A minor gray mafic anorthosite or norite commonly forms a gradational phase between syenites and the leucocratic anorthosite, or forms less resistant, more mafic layers in layered anorthosite. This unit commonly occurs as sharply bounded angular inclusions in the syenite, but as noted above is gradational into the syenite. This anorthosite is the major part of what some geologists call the Laramie Anorthosite Complex

Early Proterozoic rocks

Xsv **Older Proterozoic metasedimentary and metavolcanics rocks in the Laramie Mountains**—Pelitic schist, marble, granite gneiss, layered amphibolite, and felsic gneiss (Houston and Marlatt, 1997)

FIGURE 1

Schematic relationship between Lundy's (1978) informal members of the Casper Formation and the Casper limestones (1 -10) as defined by Benniran (1970) in the vicinity of Laramie, Wyoming. Map area falls with in diagram butt not all units crop out in the map area.



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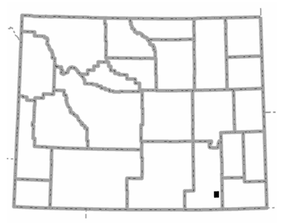

WYOMING QUADRANGLE LOCATION

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