UNITED STATES

DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

EXPLANATION for Preliminary geologic maps of the central Laramie Mountains, Albany and Platte Counties, Wyoming

By

George L. Snyder[1]

Open File Report 84-358-A

1984

These maps are preliminary and have not been reviewed for conformity with U. S. Geological Survey editorial standards and stratigraphic nomenclature.

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Background information for

Preliminary geologic maps

of the central Laramie Mountains,

Albany and Platte Counties, Wyoming

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This Open-File Report shows detailed geologic maps of the Precambrian and adjacent Phanerozoic rocks in eleven 1/24,000 scale 7 1/2′ quadrangles in a strip across the central Laramie Mountains of eastern Wyoming. Although the geologic maps are detailed, the mapping project is still in progress and some parts may be remapped before these maps are published in color. The explanatory unit descriptions are based on field observations with only cursory examination of thin sections and some chemical analyses; future laboratory work may result in changes in some descriptions.

Organization of this Open-File Report in separate lettered parts is intended to accomodate users who are interested in only parts of the report as well as those who are interested in the entire report; users may order one, several, or all of the separate lettered parts of the report.

One explanation is intended to suffice for all geologic maps although not all map units occur on every quadrangle. This explanation is listed as lettered part A of this Open-File Report. It is recommended to users as an accompaniment for each geologic map, but, if several geologic maps are ordered, only one explanation need be copied. Specific localities mentioned in explanation descriptions are tied to each quadrangle by quadrangle initials, as indicated below. The next eleven lettered parts are the separate black and white geologic maps of the Precambrian and adjacent Phanerozoic rocks within each of the eleven quadrangles, each geologic map consisting of two sheets: Sheet 1 contains geologic contact lines outlining areas identified by unit symbols on a composite topographic base; Sheet 2, which contains attitude symbols, is corner-registered to Sheet 1. The final lettered part of this Open-File Report is a set of thirteen kodachrome slides of pertinent hand-colored parts of the report. The separate lettered parts of this Open-File Report are:

Part A. Complete geologic map explanation, suitable for accompanying each geologic map.

B. Geologic map of part of Ayres Spring 7 1/2′ quadrangle, Wyoming. (AS)

C. Geologic map of Dodge Ranch 7 1/2′ quadrangle, Wyoming. (DR)

D. Geologic map of Bull Camp Peak 7 1/2′ quadrangle, Wyoming. (BCP)

E. Geologic map of Moonshine Peak 7 1/2′ quadrangle, Wyoming. (MP)

F. Geologic map of Squaw Rock 7 1/2′ quadrangle, Wyoming. (SR)

G. Geologic map of Natwick 7 1/2′ quadrangle, Wyoming. (N)

H. Geologic map of part of Bluegrass Wells 7 1/2′ quadrangle, Wyoming. (BW)

I. Geologic map of Guide Rock 7 1/2′ quadrangle, Wyoming. (GR)

J. Geologic map of Poe Mountain 7 1/2′ quadrangle, Wyoming. (PM)

K. Geologic map of Natwick SW 7 1/2′ quadrangle, Wyoming. (NSW)

L. Geologic map of Richeau Hills 7 1/2′ quadrangle, Wyoming. (RH)

M. A set of thirteen kodachrome slides: One for the "Correlation of Map Units" and index map part of the explanation, part of A above; one each for each of the eleven geologic maps, parts B through L above; and one for a composite of all eleven geologic maps mounted together in their correct positions with respect to each other.

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PART A

EXPLANATION for

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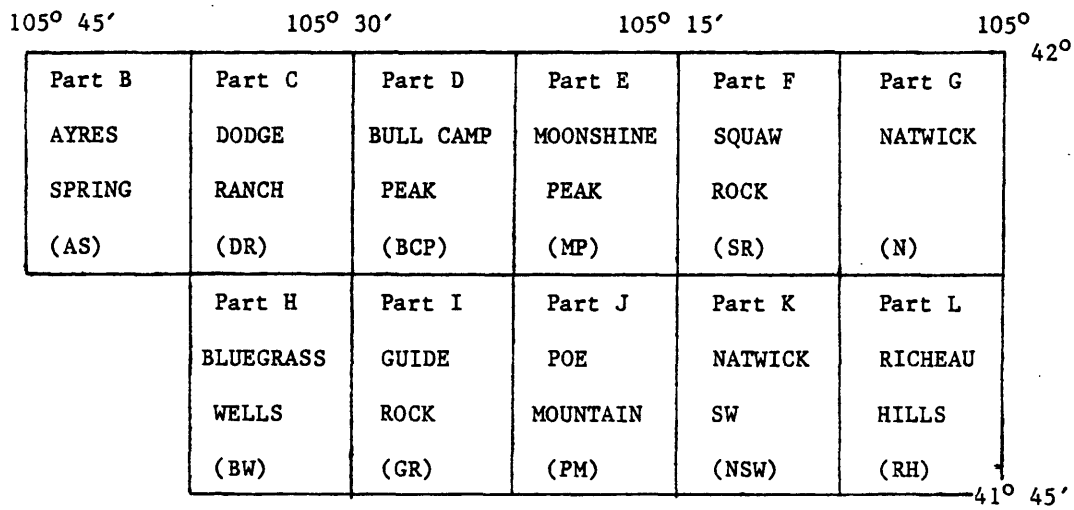
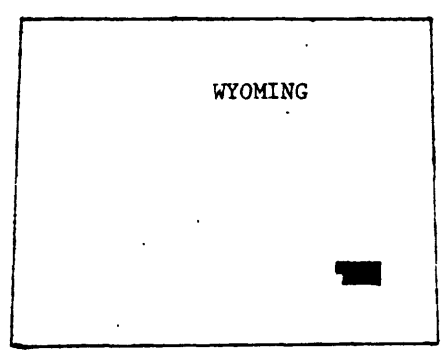
Index map





CORRELATION OF MAP UNITS

Qfp	Qc	Qtl	Qsl	QUATERNARY
Qta	Qls			
Qt				

Unconformity

Tm	Miocene	TERTIARY
Twr	Oligocene	
Tu	Eocene(?)	

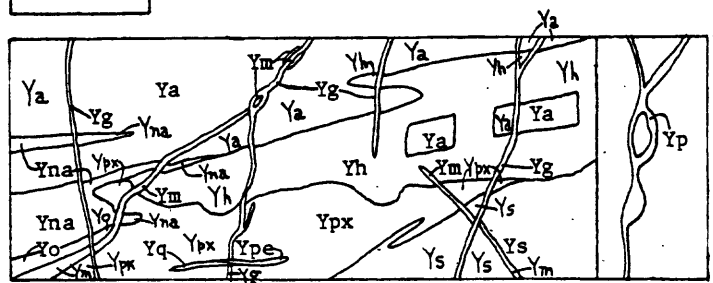
Unconformity

Ks	Lower Cretaceous	CRETACEOUS
Kc		
Jm	Upper Jurassic	JURASSIC
Js		
Trc		TRIASSIC
Trcg		
Tr Pg		PERMIAN
PPc		PENNSYLVANIAN
Pcs		
Ml — MDls		MISSISSIPPIAN AND DEVONIAN
MDs		

Unconformity

ZRb	PALEOZOIC OR UPPER PROTEROZOIC

Intrusive Suite of Sybille Creek

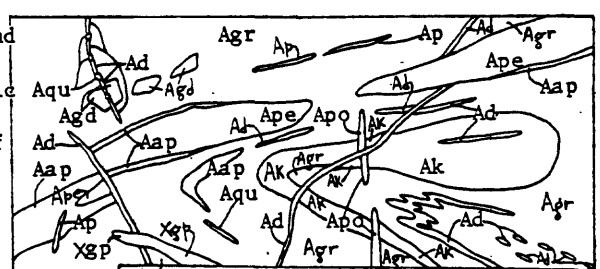


MIDDLE PROTEROZOIC (about 1.4 Ga)

Local contact metamorphism imposed on regionally metamorphosed rocks

Regional thermal metamorphism (about 1.8 Ga)

Igneous and Metamorphic Complex of Laramie River

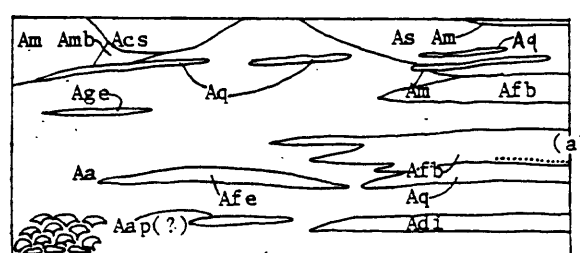


LOWER PROTEROZOIC (about 2.6 Ga) AND ARCHEAN

Regional dynamothermal metamorphism (about 2.6 Ga)

Metamorphic Suite of Bluegrass Creek

Agr



(about 2.7 Ga)

(about 3.2 Ga)

DESCRIPTION OF MAP UNITS

(Specific localities keyed to quadrangle initials identified on index map)

QUATERNARY AND TERTIARY DEPOSITS

Qfp FLOOD PLAIN ALLUVIUM (QUATERNARY)--Youngest alluvial sand and gravel deposits in largest drainages; well-rounded clasts dominated by resistant Precambrian lithologies

Qc COLLUVIUM (QUATERNARY)--Surface rubble and slope wash deposits; shown only where significant bedrock geology is covered, mainly in Richeau Hills (RH) and near Ayres Spring (AS)

Qtl TALUS DEPOSIT (QUATERNARY)--Piles of angular rock fragments beneath cliffs

Qsl LOESS (QUATERNARY)--Mainly wind-deposited silt; may include dune sand

Qta TRIBUTARY ALLUVIUM (QUATERNARY)--Alluvial sand and gravel deposits in tributaries of largest drainages; commonly separated from flood plain alluvium (Qfp) by an erosional scarp

Qls LANDSLIDE DEPOSITS (QUATERNARY)--Jumbled rock and soil debris

Qt TERRACE DEPOSITS (QUATERNARY)--Gravel and sand in terrace deposits above modern flood plains; contact lines within this unit separate lower and higher terrace deposits

Tm OGALLALA AND ARIKAREE FORMATIONS (MIOCENE)--Primarily gray to buff colored alluvial silt, sand, and gravel in part unconsolidated, in part cemented by calcite into a cliff-forming siltstone or conglomerate. Includes basal limestone in South Sybille Creek (PM).

Twr WHITE RIVER FORMATION (OLIGOCENE)--Buff alluvial silt, gravel, and gray to orange conglomerate. Includes unfossiliferous green bentonitic clays in central Cooney Hills (SR). Includes coarse basal colluvial or landslide deposits. On western side of mountains occupies numerous presently dry and partially eroded ancestral drainages. Map unit may include some unfossiliferous gravel of Miocene age, and, in Richeau Hills (RH), may include some Quaternary colluvium

Tu GRAVEL UNDIVIDED (EOCENE?)--Pink gravel, bright red Precambrian-cobble conglomerate and fine-grained redbeds. Includes redbeds near Wheatland Reservoir No. 2 (DR and BW) possibly equivalent to Wagon Bed or Wind River Formations as mapped by Harshman (1968), and red conglomerate units south of the Wheatland fault zone (NSW and RH) previously mapped as either Tertiary (Ts, McGrew, 1967c) or Precambrian (P€c, McGrew, 1967d)

MESOZOIC AND PALEOZOIC ROCKS

Ks THERMOPOLIS AND MOWRY SHALES (LOWER CRETACEOUS)--Black shale

Kc CLOVERLY FORMATION (LOWER CRETACEOUS)--Sandstone

Jm MORRISON FORMATION (UPPER JURASSIC)--Variegated green to red claystone, limestone and sandstone

Js SUNDANCE FORMATION (UPPER JURASSIC)--Siltstone and sandstone

Rc CHUGWATER FORMATION (PART)(TRIASSIC)--Nongypsiferous brick-red shale and siltstone

Rcg CHUGWATER (PART) AND GOOSE EGG (PART) FORMATIONS (TRIASSIC)--Gypsiferous brick-red siltstone, gypsum, and ribbon limestone

RPg GOOSE EGG FORMATION (PART)(TRIASSIC AND PERMIAN)--Gypsiferous limestone, sandstone and shale

CASPER FORMATION (PERMIAN AND PENNSYLVANIAN)

PPc Limestone (Permian and Pennsylvanian)--Mainly lavender gray marine limestone. Includes Hartville Formation as mapped by McGrew (1967c, d) on east side of mountains (NSW and RH)

Pcs Sandstone (Pennsylvanian)--Maroon to white sandstone, quartzite, and quartz-pebble conglomerate, mainly near base of formation when present. Adjacent to Seven Mile Creek (AS) a resinous quartzite has been quarried by Indians for projectile points

MDls MADISON LIMESTONE (MISSISSIPPIAN AND DEVONIAN)--Limestone, dolomite and sandstone member

Ml Limestone and dolomite (Mississippian)--Gray to yellow. Includes Guernsey Formation as mapped by McGrew (1967c, d) on east side of mountains (NSW and RH)

MDs Sandstone member--Basal sandstone and well-sized poorly cemented quartz granule conglomerate

CRYSTALLINE ROCKS (LARGELY PRECAMBRIAN)

ZPb BRECCIA (PALEOZOIC OF UPPER PROTEROZOIC)--Calcareous or iron-oxide-cemented breccia, for example, north of Grant Creek Reservoir (PM) and east of Ayres Spring (AS)

INTRUSIVE SUITE OF SYBILLE CREEK (MIDDLE PROTEROZOIC)

Includes all Middle Proterozoic intrusive rocks, including those previously designated part of the "Laramie Anorthosite Complex". Because the suite consists of many associated mapped intrusive lithodemes with common lithic features, including Sherman Granite, the overall name "intrusive suite of Sybille Creek" is consistent with the recommendations of the 1983 North American Stratigraphic Code (North American Commission on Stratigraphic Nomenclature, 1983, p. 860), especially the recommendations on misuse of "complex" (p. 861).

Many magmatic models have been advanced to account for the intrusive suite of Sybille Creek (for a recent summary see Fountain and others, 1981). The model that stands the test of time must be compatible with both the crosscutting and gradational aspects of various magmatic phases observed in the field as well as the geochemical character of various lithic units.

Isotopic dating of major units of the intrusive suite of Sybille Creek has produced U-Pb zircon and Rb-Sr whole-rock ages in the range of about 1,412 to 1,435 Ma clearly placing the suite in the early part of the Middle Proterozoic. The presence of inherited zircons in the Sherman Granite has complicated interpretations of the crystallization age from the U-Pb data (Aleinikoff, 1983). These data along with Sm-Nd data for whole-rock samples (DePaolo, 1980) strongly suggest that the Sherman Granite was derived, at least in part, from older, lower crustal material.

Nearly all wall rocks within 1.2 km of the contact of the rocks of the intrusive suite of Sybille Creek contain minerals indicative of a pronounced solid-state thermal overprint, and it is possible that some quartzofeldspathic rocks have been melted and moved as liquids (Fountain and others, 1981; Frost and Lindsley, 1981; Grant, 1983)

Yq QUARTZ VEIN--Quartz or quartz-epidote vein

Ype PEGMATITE DIKE--Very coarse grained quartzofeldspathic rock, locally zoned. Microcline is white, orange or green (latter unique to this unit); book muscovite and euhedral quartz prominent locally

Yg GRANITE DIKE--Pink to white, medium-grained to porphyritic granite, quartz monzonite, or granodiorite in dikes, locally layered parallel to contacts, or small plutons. Mainly represents late magmatic differentiate of primary Sybille Creek magma; locally represents mobilized wallrock melt; examples of latter appear similar to tabular Archean granite inclusions (Agr), which can be distinguished locally by gneissic structure or by presence of diabase dikes (Ad)

Ym MAFIC DIKE--Black to gray basalt or andesite dike, commonly as younger tabular intrusive bodies cutting syenite, locally as border facies of syenite. Ym and Yg dikes commonly associated together in Canyon Creek-Sybille Creek area (GR and PM) where Ym is either crosscut by Yg dikes or appears as round, pillow-like masses within Yg, implying that the rocks are nearly contemporaneous, but that Yg is slightly younger than Ym

Yp PORPHYRY DIKE--Individual dikes of uniform composition ranging from mafic porphyry and diabase through plagioclase porphyry andesite to quartz and feldspar porphyry rhyolite, in a dike swarm separate from all other phases of the intrusive suite of Sybille Creek, mapped only in the Richeau Hills (RH). Compare the independent mapping of Mueller (1982) who distinguished two units, g and pd, in the dike swarm here mapped as Yp. One sample of a quartz porphyry rhyolite dike near the dirt road in the SW 1/4 of sect. 1, T. 21 N., R. 69 W. has given a whole-rock Rb-Sr model age of 1,450 $\pm$ 30 Ma (Z. E. Peterman, written communication, 1982)

Yo IRON-OXIDE GABBRO OR ANORTHOSITE--Includes either melagabbro with 3 to 30 percent interstitial magnetite-ilmenite or anorthosite with irregular veinlike segregations of nearly pure magnetite-ilmenite. Locally prospected for iron ore

Ys SHERMAN GRANITE--Medium- to coarse-grained pink to orange biotite hornblende granite, syenogranite, quartz monzonite and granodiorite. Gradational with or interfingered with syenite. Forms center of largely covered "antiform" crossing Grant Creek (PM). U-Pb dating of zircon from the Sherman Granite is complicated by the presence of inherited zircon, but the data suggest an age between 1,415 and 1,435 Ma (Aleinikoff, 1983). This interpretation is consistent with a Rb-Sr whole-rock isochron age of 1,430 ± 20 Ma (Zielinski and others, 1981)

Yh HORNBLENDE SYENITE--Coarse-grained, brown to black hornblende biotite syenite, quartz syenite and monzonite. Grades by occurrence of pyroxene into pyroxene syenite, by relative increase of plagioclase into noritic anorthosite, and by relative increase of quartz and microcline into Sherman Granite. Includes pink leucocratic fine-grained hornblende syenite dikes and sills intercalated in wallrock section in northern part of area (MP and SR)

Ypx PYROXENE SYENITE--Coarse-grained light brown (where weathered) to black (where fresh; rare in natural exposures) hornblende pyroxene syenite and microcline porphyry syenite, generally homogeneous and massive but rarely layered. Commonly weathers to a coarse grüss or granular soil forming grassy plains without prominent exposures. Detailed mineralogical studies indicate that this rock crystallized from a shallow magma body (5 to 7 km) at temperatures from 825° to 1,100° C and pressures of 1.5 to 2 kbar (Frost and Lindsley, 1981; Fuhrman and Lindsley, 1983). Zircons from both hornblende syenite and pyroxene syenite define a single chord on a U-Pb concordia plot indicating an age of 1,435 ± 15 Ma (Hills and Houston, 1979, p. 91; Subbarayudu, 1975; Subbarayudu and others, 1975)

Yna NORITIC ANORTHOSITE-- Coarse-grained gray mafic anorthosite or norite, commonly a phase gradational between pyroxene syenite and anorthosite or forming less resistant mafic interlayers in layered anorthosite

Ya ANORTHOSITE--Medium- to coarse-grained white to light bluish-gray anorthosite, generally leucocratic and massive to layered to brecciated; commonly forms ledges in canyon walls. Includes mafic-clot anorthosite with interstitial concentrations of 5 cm orthopyroxene, olivine, and magnetite-ilmenite in North Sybille Canyon-Middle Sybille Creek area (PM). Contains sweeping layers from several centimeters to many meters wide and continuing for hundreds of meters, especially from Johnson Creek to head of Sybille Canyon (PM and GR). Elongate plagioclase crystals aligned parallel to these layers indicate that they are flow layers. Local truncation of layers by other layers indicates a time sequence, shown with crossbed symbol on map. Anorthosite commonly occurs as sharply bounded angular inclusions in syenite, but may be gradational with syenite through noritic anorthosite

IGNEOUS AND METAMORPHIC COMPLEX OF LARAMIE RIVER
(LOWER PROTEROZOIC AND ARCHEAN)

Includes metamorphosed granite, granite gneiss, and other formerly igneous or partly igneous rocks older than the intrusive suite of Sybille Creek and, at least in part, younger than the metamorphic suite of Bluegrass Creek. About three quarters of the exposures in the gorge of the Laramie River where it crosses the Laramie Mountains are in rocks of this complex. Identification as a complex is consistent with the 1983 North American Stratigraphic Code (North American Commission of Stratigraphic Nomenclature, 1983) because the assemblage includes diverse rocks of several classes, only a few of which are mappable. Only part of the igneous and metamorphic complex of Laramie River may be a primary intrusive into the metavolcanic and metasedimentary rocks (see discussions of Condie, 1969a, b, and Smithson and Hodge, 1969). Part, the volumetrically most prominent granite unit (Agr), may have been the basement on which the metavolcanics and metasediments of the metamorphic suite of Bluegrass Creek were deposited, but which was later remobilized in one or more regional metamorphisms to give the map appearance of a primary intrusive contact. The regional metamorphisms were in the amphibolite and granulite facies, and took place partly during the Archean and partly during the Early Proterozoic. Later

emplacement of the intrusive suite of Sybille Creek re-remobilized and re-recrystallized some units of the igneous and metamorphic complex of Laramie River within 1.2 km of this contact. Most radiometric ages of rocks in this complex are Archean but the complex also includes at least one Lower Proterozoic intrusive unit (Xgp)

Xgp PYROXENE GRANITE--Bright pink flow-layered to massive granite with prominent bright green clinopyroxene and ubiquitous minor calcite. Mapped only in Richeau Hills (RH) and in the anticlinal core southeast of Rosentretter School (NSW). Preliminary U-Pb data for zircons from one crop of pyroxene granite in the NW 1/4 SW 1/4 NE 1/4 sect. 11, T. 21 N., R. 69 W. (RH) are about 1,700 Ma (K. R. Ludwig, 4/11/84 oral comm.)

Aqu QUARTZ VEIN--White bull quartz in veins, commonly between separated boudins of deformed amphibolite dikes. Although such quartz veins are clearly younger than the amphibolite dikes in this area, quartz veins have been shown to be older than comparable diabase dikes northwest of this area (Harshman, 1968)

Ap PEGMATITE--White to flesh-colored very coarse grained quartzofeldspathic rock. Swarms of pegmatite sills locally grade along strike into swarms of granite sills (Agr)

Ape PERIDOTITE--Dark gray to black generally unaltered medium-grained ultramafic intrusive rock, locally with outer shells of altered peridotite (generally not mapped separately). Constituents include abundant fresh yellow olivine, commonly with corona reaction shells against plagioclase, and enstatite, which may occur in a medium-grained groundmass, in uniformly scattered large porphyroblasts, or, rarely, in layers. In some rocks enstatite is predominant. Other constituents include clinopyroxene, plagioclase, biotite, magnetite and chromite. The least altered peridotite bodies generally occur in granite terrane, and they generally cut or contain inclusions of amphibolite dikes, but locally peridotite bodies are cut by amphibolite dikes

Aap ALTERED PERIDOTITE--Dark green medium-grained actinolite talc chlorite ultramafic rocks locally containing carbonate. Generally even-grained and massive, but locally layered. Generally occur in metavolcanic-metasedimentary terrane but some occur elsewhere. Some bodies locally contain remnant olivine. Most bodies are believed to be altered Ape intrusives that intruded wet volcanics or sediments rather than dry granites, but some may be komatiite flows contemporaneous with more abundant basaltic flows (see Holden and Snyder, 1983, p. 423). Spinifex textures indicative of ultramafic extrusives are rare or lacking

Ad DIABASIC AMPHIBOLITE DIKE--Speckled greenish black mafic dikes ranging from granular hornblende-plagioclase-quartz amphibolite to clinopyroxene-hornblende-plagioclase diabase. Small grains of metamorphic garnet commonly nucleated along contacts between hornblende and plagioclase; a few metamorphic garnets are as large as 5 cm in diameter. Ad dikes cut or contain inclusions of plagioclase porphyry amphibolite dikes (Apo); locally Ad dikes cut other Ad dikes. Many Ad dikes occur in Aa metavolcanic amphibolite, but they are difficult to recognize except in perfect exposures [as on southwest shoulder of Squaw Mountain (MP)] and it is impractical to map them uniformly. Ad inclusions in syenite of the intrusive suite of Sybille Creek have new brown hornblende, clinopyroxene, enstatite, and olivine

Apo PLAGIOCLASE PORPHYRY AMPHIBOLITE DIKE--Dark greenish black hornblende-plagioclase-quartz amphibolite dikes with 15 to 25 percent of 1 to 5 cm (rarely as much as 25 cm) plagioclase phenocrysts; scapolite and garnet are common minor constituents. Plagioclase phenocrysts are commonly deformed to augen; Apo dikes in the supracrustal section seem more universally sheared than those in granite terrane. Border zones of Apo dikes commonly but not invariably nonporphyritic. Examples known of Apo inclusions in Ape [Tony Ridge (BCP)] and Ypx [head of Canyon Creek (GR)]

Agr GRANITE--Pink medium- to coarse-grained, uniformly massive to extensively layered granite, quartz monzonite, alaskite and related gneisses. Biotite is generally prominent but muscovite is locally conspicuous. Massive varieties are equigranular coarse- to fine-grained rocks in bodies meters to kilometers

long. Gneisses may have very subtle foliation defined by feldspars, quartz or biotite, or subtle to prominent felsic or mafic compositional layers, or 1 to 2 cm repeated pegmatitic layers with relatively uniform granite between the pegmatitic layers. Layering may be due to intrusive igneous or metamorphic flowage, to metamorphic recrystallization of formerly extrusive flow layers or bedding in arkose, to progressive tectonic disruption of former diabase dikes, to metamorphic segregation of leucosomal first melts, to lit par lit injection of leucosomal first melts from nearby rocks (all of these origins probable locally), or perhaps to other causes unmentioned and currently unsuspected. Different lithologic varieties can be in sharp or gradational contact with each other, can maintain their identities as distinct units for kilometers or can disappear in meters. Agr unit as mapped may overlap with Yg granite dike unit near contact with intrusive suite of Sybille Creek. Rb-Sr dating studies of samples from the Agr unit have given ages of 2,490 + 50 Ma (Hills and Armstrong, 1974, recalculated) and 2,580 $\pm$ 20 Ma (Z. E. Peterman, written comm., 1983). Rb-Sr models imply some older history in the range of 2,740 to 3,210 Ma in the Richeau Hills (RH) and Cooney Hills (SR and N)(Z. E. Peterman, written comm., 1983)

Ak MICROCLINE AUGEN GRANITE GNEISS--One mappable variety of Agr, with 10 to 30 percent giant microcline phenocrysts or porphyroblasts 2.5 to 7.5 cm in diameter. Partly gradational with Agr granite, partly cuts nonporphyritic granite, and partly cut by nonporphyritic granite dikes. Largest area of coarsest porphyroblastic gneiss is in an asymmetric double-dumbbell-shaped mass on Squaw Mountain (MP and Sr). Other areas of very corse granite gneiss with fewer augen are gradational with Agr on the west side of the mountains (DR). U-Pb data for zircons from the granite gneiss of Squaw Mountain indicate an age of about 2,595 Ma (Z. E. Peterman, written comm., 1982)

Agd HORNBLENDE GRANODIORITE--Coarse-grained to very coarse-grained speckled gray hornblende-plagioclase or hornblende-epidote-plagioclase granodiorite or diorite, generally as angular inclusions in Agr

METAMORPHIC SUITE OF BLUEGRASS CREEK
(ARCHEAN)

Includes all (generally layered) metasedimentary or metavolcanic rocks that are exposed in greater quantities than the rocks of any other major unit along the course of Bluegrass Creek (BCP, BW, GR, MP, and PM). Most exposures are in a belt south and east of Elmers Rock [itself part of unit Agr (BCP)] that extends from the head of Bluegrass Creek (BW and GR) across the mountains to the egress point of the Laramie River (SR). This belt was referred to as the "Elmers Rock greenstone belt" by Graff and others (1981, 1982). The metamorphic suite of Bluegrass Creek includes this belt and also many metavolcanic or metasedimentary outliers, for example, north and northeast of Sheep Mountain (NSW), in the Richeau Hills (RH), at and near the Wheatland Marble Quarry (Hightower SW 7 1/2′ quad.), on Squaw Mountain (MP and SR), west of the North Albany Club (DR), in Duck Creek (BCP and MP) along the Laramie River east of the Bookout Ranch (MP), and elsewhere. The order of units below and in the accompanying Correlation of Map Units box is a simplification of an only partially understood, but necessarily complex, stratigraphic order.

Dating of all of the stratigraphic units in the map area is indirect, that is they are older than about 2,600 Ma as shown by isotopically dated bodies that intrude them. However, a metarhyolite (porphyritic felsic gneiss) cropping out on the northwest flank of Sellers Mountain in the Garret 7 1/2′ quad. (Langstaff, G. D., 1984, p. 120-123) has been dated by the U-Pb zircon method at 2,729 $\pm$ 62 Ma (Z. E. Peterman, written comm., 1984). The metarhyolite is interlayered with mafic schists in a metavolcanic and metasedimentary rock section that here is recognized as another outlier of the metamorphic suite of Bluegrass Creek

Am MARBLE--Buff-weathering white to dark brown fine-grained to very coarse-grained marble that comprises most of the possibly youngest stratigraphic unit in the area. Marble is in contact with many other lithologies indicating a possible unconformity at its base. Marble grades into calc-silicate rock (Acs) by decrease of carbonate and increase of calc-silicate minerals. Prominent varieties of rocks mapped as Am include:

White dolomite and tremolite dolomite, well represented at the Wheatland Marble Quarry (Hightower SW 7 1/2' quad.), one mile west of the Adam Boyd Ranch (MP) (know locally as the Circle M or Neuces Ranch during the late 1970's and early 1980's), in a quarry adjacent to eastern McMurray Creek (SR)(subtle but regular layering possibly representing algal bedding is especially well developed here), and surrounded by Tertiary gravels west of the Cooney Hills (SR).

White to gray very coarse grained calcite marble, probably representing dedolomitized dolomite, best developed south of the Wheatland fault zone (NSW and RH).

Well-layered clear brown fine- to medium-grained calcite marble in numerous thin nonresistant interlayers in schist well exposed between Bluegrass Creek and Meadow Spring Ranch (MP).

White green-to-brown-spotted dolomite-calcite marble with spots representing nearly completely antigoritized chondrodite. Well exposed in numerous thin layers in the Richeau Hills (RH), north and west of Sheep Mountain (NSW), on the south flank of Squaw Mountain (MP and SR), and locally in the Cooney Hills (SR); antigoritized chondrodite dolomite has been quarried as verd antique in the drainages north of Marble Quarry Creek (Hightower SW 7 1/2' quad.). Where this rock is included in or is near the intrusive suite of Sybille Creek, as happens repeatedly within 3.2 km of Red Mountain (PM), north of lower Bluegrass Creek (MP), on Yaunt Mountain (PM), or between the heads of Trail Creek and Tower Canyon (GR and PM), the antigoritized chondrodite is reconstituted into olivine(?), or is redistributed in asbestos veins or regularly layered aggregates that resemble fossils, specifically "Eoozooin" (Hans Hofmann, oral comm., 1983)

Amb MARBLE BRECCIA--House-sized blocks of marble and marble breccia on lower slopes south of the Wheatland fault zone and east of Brush Creek (RH), possibly landslide deposits of very old fault breccias that were reactivated in the Laramide orogeny

Acs CALC-SILICATE ROCK--Greenish gray calc-silicate rock with minor carbonate (locally grading to marble, Am) consisting of green diopside, white aluminous epidote or clinozoisite, gray wollastonite(?), brown phlogopite, orange garnet, white scapolite, and white to green clinoamphibole. Varieties near to or included in the intrusive suite of Sybille Creek [as between West Plumbago Draw and Canyon Creek (GR and PM), or near the head of Johnson Creek (GR)] have 7.5 cm euhedral phlogopite and cockscomb diopside, or 2.5 cm margarite(?) and calcite developed locally

As PELITIC SCHIST--Layered silvery-gray metashales, generally with excess alumina, constitute the largest part of a stratigraphic unit near the upper part of the section; this pelitic schist unit may grade laterally into the marble unit or may be unconformably beneath the marble unit. Best exposures are in one major and several minor belts between George Creek and the William Boyd Ranch (MP)(known locally as the Chislo Ranch in the late 1970's and early 1980's), several large isolated mapped bodies within 3.2 km of Moonshine Peak (MP), plus smaller patches near the Adam Boyd Ranch (BCP and MP), in the Cooney Hills (N and SR), Richeau Hills (RH), and elsewhere. Generally contains more micas, especially muscovite, than granular minerals, but quartz is nearly ubiquitous. Sillimanite, kyanite and andalusite, alone or in any combination, are the most characteristic minerals. Plagioclase, cordierite, pink garnet (locally as large as 7.5 cm), potassium feldspar, fuchsite, chlorite, corundum, and relict staurolite are present in decreasing amounts. Sillimanite is the most characteristic aluminum silicate mineral; it occurs in both clear prisms and fibrolitic aggregates, and pseudomorphic pinite is a common retrogressive alteration product. Kyanite is blue, green, black, or white; it is commonly unnoticed in hand specimens where it is armored by other minerals. One schist with

2.5 to 7.5 cm blue to white kyanite and 2.5 cm light purple cordierite has been quarried as a mineralogical curiosity on both sides of Grizzly Creek a mile northwest of the Bookout Ranch in the Reese Mountain 7 1/2' quad. Another muscovite quartz schist with black kyanite has been prospected near a George Creek ranch road (MP). An unusual felsic muscovite gneiss with pleochroic bright pink andalusite is exposed in hillside ledges 2.1 km southeast of the William Boyd Ranch and north of Bluegrass Creek (MP). Green fuchsite schist with local pink andalusite has been quarried as a mineralogical curiosity 2.4 km south southeast of the William Boyd Ranch and south of Bluegrass Creek (MP). Blue kyanite-brown staurolite schist is exposed in several localities in the western Cooney Hills (SR) and south of the Adam Boyd Ranch (MP). Pelitic schists close to or included within the rocks of the intrusive suite of Sybille Creek contain a suite of contact metamorphic minerals including a second type of nearly invisible greasy gray cordierite, plus sillimanite, garnet, andalusite, spinel, corundum and local hypersthene; they may also be the source of leucosomal melts (Grant, 1983, p. 584)

Afb FELSIC BIOTITE GNEISS--Speckled gray feldspar-quartz-biotite gneiss and granular schist. Forms at least two stratigraphic units near the middle of the metamorphic suite of Bluegrass Creek. Some felsic biotite gneiss is apparently in the upper half of the section and in contact with the upper pelitic schist unit, for example, northwest of the syenite and largely between Bluegrass Creek and McMurray Creek (MP). Other felsic biotite gneiss is surrounded by amphibolite in the lower part of the amphibolite section, for example, east and west of the Laramie-River-to-Tunnel-Creek water diversion tunnel (BCP), on both sides of Bluegrass Creek west and south of the Adam Boyd Ranch (BCP and MP), and in George Creek (MP). The relative stratigraphic position of the felsic biotite gneisses and granular schists in the western Cooney Hills (SR) and the Richeau Hills (RH) and nearby areas is less certain. These may represent a third stratigraphic level at the very bottom of the section (not shown in the diagrammatic Correlation of Map Units box, or possibly the Agr granites have intruded in these areas to a higher level in the section

The rocks of this unit were probably derived from subgraywacke-type silts, sands, and gravels, or, more rarely, water-deposited ash beds. Locally graded and channelled quartz granule microconglomerates (shown with dot symbol) are present near the head of Slate Creek (MP), in the Richeau Hills (RH), and in the western Cooney Hills (SR). Polymictic megaconglomerates (also shown with dot symbol) with pebbles and cobbles from 1 to 15 cm in diameter are exposed 1.6 km southeast of the point where the county road crosses the Laramie River (BCP), both sides of the mouth of Mill Creek (BCP), just northwest of the old McGill Ranch (PM)(known locally as the headquarters of the Flying X Ranch in the late 1970's and early 1980's), 1.1 to 2.3 km southwest of the William Boyd Ranch (MP), northwest of the syenite between Halleck Creek and the county road (MP), and in the eastern Cooney Hills (N). Some cobbles have tectonically streched length/width ratios of as much as 10/1. Water-deposited ash beds may be represented by the layered felsic gneiss and schist section in Reed Creek (SR and MP). A swarm of felsic gneiss interlayers or inclusions in granite is prominent north of the two Kennedy Ranches (DR and BCP). Rocks of this map unit seem least observably affected by proximity to the rocks of the intrusive suite of Sybille Creek; individual pebbles are preserved in the contact environment near Bluegrass Creek (MP)

Age GEDRITE SCHIST--Brown, green or gray orthoamphibole schists are interlayered with or gradational to either pelitic schists or amphibolites, apparently an excess magnesia variety of the former or an excess alumina variety of the latter. These rocks are always characterized by gedrite or anthophyllite, commonly in splayed aggregates resembling turkey tracks, plus lesser amounts of cordierite, chlorite, staurolite, and rare kyanite or andalusite

Aa AMPHIBOLITE--Medium-grained green to black, layered, massive or pillowed granular hornblende plagioclase amphibolite, commonly interlayered with calc-silicate rock or containing calc-silicate

pods 1/2 cm to 1 m in diameter. Locally includes layered turkey-track-clinoamphibole garnet amphibolite, and some diabasic amphibolite. Uniformly layered amphibolite and calc-silicate layered or podded amphibolite are present throughout the section and in all isolated areas of unit Aa. The layered amphibolite probably represents water-deposited basaltic ash and the calc-silicate parts may indicate that the volcanic ash commonly entered a carbonate-depositing environment. If so, CO_2 has been removed from the calc-silicate rocks during subsequent metamorphisms. Massive and pillowed amphibolites at five stratigraphic levels probably represent subaqueous basaltic flows. Pillows are best developed just above the probable base of the section in the area between the county road and Bluegrass Creek west of the William Boyd Ranch (BCP), especially in the area near Tunnel Creek. Layered turkey-track-clinoamphibole garnet amphibolite is generally confined to the upper half of the supracrustal section, especially in the area between William Boyd Ranch (MP) and the McGill Ranch (PM) and east of the William Boyd Ranch. Turkey-track amphibolites are chemically of andesite composition and may have been derived from a more distant source than the metabasalts since massive or pillowed rocks are absent. Some of the massive and most of the diabasic amphibolites probably represent basaltic intrusives equivalent to unit Ad. Ad dikes may be just as abundant in Aa as they are in Agr but it is not practical to map the dikes in Aa in most areas. Contact metamorphosed Aa is similar to contact metamorphosed Ad, except that the pre-metamorphic compositional layering is maintained in the former

Adi DIORITE--Massive dark green coarse-grained amphibolite of dioritic composition mapped only in the lower Laramie River canyon (MP) where it apparently occurs in a tight syncline. Although this amphibolite is massive and without recognized volcanic structures, it may well represent a thick lava flow, perhaps equivalent to one or more of the pillowed flows in Aa elsewhere

Aq QUARTZITE--Massive white, greenish white or brown quartzite. occurs at two levels, one near the top and one near the bottom of the metamorphic suite of Bluegrass Creek. The upper quartzites occur either as thin layers intercalated with pelitic schist, marble and amphibolite in a belt from lower George Creek to the county road east of the William Boyd Ranch (MP)[also in western Cooney Hills (SR)], or as a thick unit near the center of a carbonate recumbent fold northeast of Sheep Mountain (NSW). The lower quartzite is exposed in lowermost Slate Creek (SR) or in a belt from Yaunt Mountain (PM) to Tower Canyon (GR). Fragments of the latter quartzite form mappable inclusions in the Proterozoic syenite. In several inclusions, quartzite is associated with marble. Some quartzite of unknown stratigraphic position occurs largely surrounded by Archean granite in the Richeau Hills (RH). Other quartzites between the heads of Johnson Creek and School Creek (GR) were surrounded by Proterozoic syenite after they were surrounded by Archean granite.

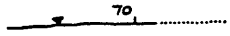
The quartzites are composed of 90 percent or more quartz, and contain minor muscovite or fuchsite and local swarms of sillimanite. Fuchsite quartzite has been quarried for ornamental stone southwest of Squaw Mountain (MP). The thicker quartzites were originally probably slightly clayey beach or channel sands. However, pebbles, crossbeds or other sedimentary features have not been identified in these quartzites, and some of the thinner beds may have originally been cherts rather than sandstones. The brown quartzites are best exposed near the county road east of the William Boyd Ranch (MP), and probably owe their color to iron staining derived from weathered sulfides. If so, these quartzites may represent a lateral sulfidic facies of lean iron formation

Afe BANDED IRON FORMATION--Layered gray quartz-magnetite (more than 30 percent) granofels, quartz-grunerite-magnetite schist, and quartz-grunerite-garnet-magnetite (less than 4 percent) lean iron formation. Mapped only north of Moonshine Peak and George Creek

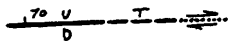
Aap? ALTERED PERIDOTITE--Described previously under igneous and metamorphic complex of Laramie River. Some may represent altered komatiite flows in the metamorphic suite of Bluegrass Creek

DESCRIPTION OF MAP LINES AND SYMBOLS

LINES

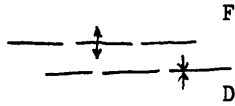


CONTACT--Showing dip. Dotted where concealed. Solid triangle indicates good exposure



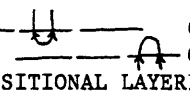
FAULT--Showing dip. Dashed where approximately located; dotted where concealed. U, upthrown side; D, downthrown side; T overriding plate; arrows indicate apparent transverse movement

FOLD TRACE



Crest of anticline

Trough of syncline



Overturned anticline

Overturned syncline

DIAGRAMMATIC TRACE OF COMPOSITIONAL LAYERING IN ANORTHOSITE--Believed to be igneous flow foliation with felsic layers more resistant and mafic layers less resistant. Sketched from field observations, generally from a distance

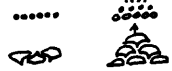
PRIMARY FEATURES

Arrow points toward top of bed. Feature without arrow indicates observation of described feature with no geopetal direction determined

Truncation of channel crossbeds in layered metasediments, or of flow-layering in anorthosite

Layering of possible algal stromatolites in dolomite

Bedding or graded bedding in quartz granule graywacke or polymictic conglomerate



Lava pillows in extrusive amphibolite

PLANAR FEATURES

STRIKE AND DIP OF BEDS

Inclined

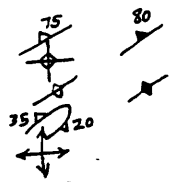
Horizontal

Vertical

Overturned

Folded

STRIKE AND DIP OF METAMORPHIC SCHISTOSITY OR IGNEOUS FOLIATION--May be combined with bedding data. Open symbols in rocks of igneous and metamorphic complex of Laramie River or metamorphic suite of Bluegrass Creek; solid symbols in rocks of intrusive suite of Sybille Creek



Inclined

Horizontal

Vertical

Folded

Quaquaversal

GENERAL STRIKE AND RANGE OF DIP OF GENTLY FOLDED SCHISTOSITY OR FOLIATION

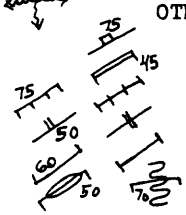
Inclined

Horizontal

Vertical

Quaquaversal

OTHER PLANAR FEATURES



Inclined joint set

Inclined quartz vein in peridotite

Inclined or vertical calcite or calcite-quartz vein

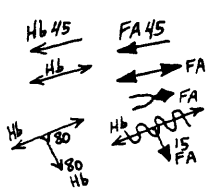
Inclined or vertical shear plane

Inclined or vertical compositional layer in anorthosite

Inclined axial plane of one fold, or multiple folds

LINEAR FEATURES

BEARING AND PLUNGE OF LINEATION--May be combined with planar features. Point of observation at tail of inclined arrow or center of horizontal arrow. Abbreviations indicate nature of lineation: Bi, elongate biotite grains; Bi-Bi, biotite trains; FA, minor fold axis; F-AUG, feldspar augen; FSP, feldspar; Gr-B's, granite boulders; Gr-P's granite pebbles; Hb, hornblende; Hb-Bi, hornblende-biotite pods; K, potassium feldspar; Ky, kyanite; MC, mafic clots; Q, quartz; Q-P's, quartz pebbles; Si, sillimanite; St, staurolite; TREM, tremolite



Inclined

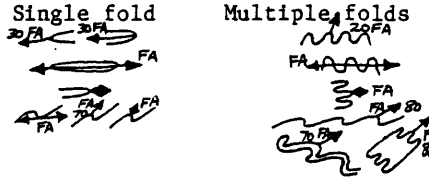
Horizontal

Vertical

Multiple

BEARING AND PLUNGE OF AXES OF MINOR FOLDS

Single fold Multiple folds



Inclined
Horizontal
Vertical
Known map sense
Folded folds

WORKS OF MAN

Borrow pit
Quarry
Cu Prospect pit. Letter symbols shown where known: Cu, copper, F, fluorite; Fe, iron
Adit
Mine shaft
CR-15 Cored drill hole with hole number (BW)
3542 Sample locality with sample number

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