WYOMING STATE GEOLOGICAL SURVEY Erin A. Campbell, Director and State Geologist Laramie, Wyoming





metric topographic map of the Rock River, Wyoming Quadrangle, 1982 Base hillshade derived from United States Elevation Data (NED) (10 m resolution), 2013; azimuth 315°, sun angle 45°, vertical exaggeration 2 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 central zone National Geodetic Vertical Datum of 1927 Nyoming State Geological Survey P.O. Box 1347 - Laramie, WY 82073-1347 Phone: 307-766-2286 - Fax: 307-766-2605 Email: wsgs.sales@wyo.gov



## PRELIMINARY GEOLOGIC MAP OF THE ROCK RIVER 30' x 60' QUADRANGLE, ALBANY, PLATTE, AND LARAMIE COUNTIES, WYOMING

SCALE 1:100,000

Contour interval 20 meters

James E. Stafford, Charles F. Hoffman, Seth J. Wittke, Patricia M. Webber, and B. Ronald Frost

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5,000 10,000 15,000 20,000 25,000 30,000 35,000 40,000 45,000 50,000 55,000 60,000 65,000 Feet

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Prepared in cooperation with and research supported by the U.S. Geological Survey, National Cooperative Geologic Mapping Program, under USGS award number G20AC00199. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government. Suggested Citation: Stafford, J.E., Hoffman, C.F., Wittke, S.J., Webber, P.M., and Frost, B.R., 2021, Preliminary geologic map of the Rock River 30' x 60' quadrangle, Albany, Laramie, and Platte counties, Wyoming: Wyoming State Geological Survey Open File Report 2021-5, scale 1:100,000.









INDEX TO SOURCES OF GEOLOGIC MAPPING (Numbers are noted in REFERENCES AND SOURCES OF MAP DATA)



C	enozoic Alluvium (Holocene)—Unconsolidated to loosely consolidated clay, clay-rich soil, silt,
QI	sand, gravel, cobbles, and boulders within and along most drainages; locally derived <b>Playa lake lacustrine deposits (Holocene)</b> —Light gray-brown, compact expandable
Qsl	<ul> <li>Sand and loess (Holocene and Pleistocene)—Dunes, made up of very fine to fine- grained windblown sand. Numerous unmapped small-scale locations occur within</li> </ul>
Qt	the map area; variable thickness <b>Terrace deposits (Holocene and Pleistocene)</b> —Unconsolidated to locally weakly cemented silt, sand, gravel, and cobbles, located above and between current alluvial systems; most are gently dipping. Includes areas mapped as gravel pediments and
Qc	<ul> <li>terrace gravels. Thickness generally less than 7.5 m (25 ft)</li> <li>Colluvium (Holocene and Pleistocene)—Unconsolidated clay, silt, sand, gravel, cobbles, and boulders, typically in clay-rich soil matrix; locally derived from older geological units upslope. Combined alluvial fans, minor debris flows, and slope</li> </ul>
Qof	<ul> <li>wash, typically at or near base of steep slopes. Thickness not determined</li> <li>Old fan (Holocene and Pleistocene)—Poorly sorted clay, silt, sand, and gravel; crudely bedded to non-bedded with some debris flow component. Limestone cobbles are common. Currently inactive and dissected, often occurring as erosional remnants. Grades into older terrace deposits toward the west, in the northern part of the map area. Thickness 0, 30 m (0, 10 ft)</li> </ul>
Qot	<ul> <li>Old terrace (Holocene and Pleistocene)—Beds of coarse sand and gravel with occasional boulders and lenses of silt and clay. Limestone cobbles are common. Often occurs as erosional remnants ranging from 7– 30 m (23–99 ft) above present stream flood plains. Some locations may be older alluvial fan remnants. Thickness 0–3 m (0–10 ft)</li> </ul>
То	<b>Ogallala Formation (Pliocene and Miocene)</b> —Tan to brown, unconsolidated to well- cemented sandstone, siltstone, volcanic ash, and conglomerate (gravel to boulder sized), interbedded with claystone and thin beds of limestone toward the east. Conglomerate clasts are primarily Precambrian igneous material, with limestone clasts predominating in some conglomerates near the base of the formation. Thickness 0–100 m (0–330 ft)
Та	Arikaree Formation (Miocene)—Light- to orange-gray, fine- to coarse-grained sandstone and siltstone interbedded with some thin beds of gray to yellowish-gray and green claystone, dense hard gray freshwater limestone, white to dark-gray volcanic ash, and numerous layers of light-gray to bluish-gray conglomerate. Coarse components of the conglomerate are chiefly blue-gray anorthosite. Thickness $0-100 \text{ m} (0-330 \text{ ft})$
Twr	<ul> <li>White River Formation (Oligocene)—Medium- to coarse-grained, rusty-yellow to light-brown, locally buff to light-gray arkosic conglomerate with a tuffaceous clay matrix. Clasts average less than 1 cm (0.4 in) in diameter; sparse subrounded cobbles and boulders of Precambrian granitic and anorthositic rocks up to 1.5 m (5 ft) across. Interbedded with very poorly sorted beds of similar color consisting of pebbles and cobbles averaging several centimeters in diameter. Capped by large boulders up to 5 m (16 ft) in diameter. Forms high mesa surface in secs. 20 and 29, T. 18 N., R. 70 W. Sharp disconformable contact with the underlying Pierre Shale. 3–23 m (10–75 ft) thick</li> </ul>
Tmo	Miocene and Oligocene rocks, undivided—Light- to orange-gray, medium- to fine- grained, poorly cemented tuffaceous sandstone, with intermittent calcareous sandstone concretions and siliceous root casts. Dark-gray sandstone and channel conglomerate with Paleozoic and Precambrian rocks in a calcareous sandstone matrix. Red conglomerate with light-red, loosely cemented conglomerate composed of pebbles, cobbles, and boulders derived from Paleozoic and Precambrian rocks in an orange-red claystone and sandstone matrix. Unit includes members of the White River Formation and may include the Arikaree Formation where undivided
Twdr	Wind River Formation (Lower Eocene)—Upper part is greenish-gray to white, medium- to very fine grained, micaceous silty sandstone with interbedded carbonaceous shale and red- and green-banded bentonitic mudstone. Brown-weathering nodules of limy siltstone in some sandstone beds. Bone fragments present. Basal part is gray to brown, coarse- to very coarse grained, arkosic cross-bedded sandstone with interbedded thin lenticular conglomerate and siltstone beds. Thickness greater than 122 m (400 ft)
Tha	Hanna Formation (Paleocene)—Gray to light-brown, coarse- to very coarse grained, locally arkosic, brown-weathering, massive sandstone with interbedded thin conglomerate, gray shale, carbonaceous bentonitic coaly shale, and sandy gray siltstone. Sandstone beds are cross-bedded and have local channels at base
Kmb	<ul> <li>Medicine Bow Formation (Upper Cretaceous)—Light-gray to light-brown claystone, sandstone, and siltstone with coal and carbonaceous shale beds. Constrained to the Laramie Basin on this quadrangle. Thickness 0–122 m (0–400 ft)</li> </ul>
Kle	<b>Lewis Shale (Upper Cretaceous)</b> —Light-gray, fine- to very fine grained, cross bedded, iron-stained sandstone with interbedded dark-gray to black siltstone, shale, and carbonaceous shale; many thin stringers of coal and coaly carbonaceous shale. Thin bed of concretionary dense black ironstone in the lower part. Sandstone beds contain fossiliferous calcareous zones and spherical and ellipsoidal calcareous concretions. Thickness 670–790 m (2 200–2 600 ft)
Kmv	<ul> <li>Mesaverde Formation (Upper Cretaceous)—Sandstone with interbedded dark-gray to black siltstone and shale. Sandstone beds are gray to brown, fine grained, medium bedded, contain calcareous zones with abundant marine fauna, and weather dark brown. Contains large limy sandstone concretions as much as 1.8 m (6 ft) in diameter. Also includes the Pine Ridge Sandstone Member: light-brown to white fine-grained, iron-stained, cross-bedded sandstone with interbedded brown to black carbonaceous siltstone, shale, and coal in the upper half. Coal lenticular and poorly exposed. Thickness up to 490 m (1,600 ft)</li> </ul>
Ks	<b>Steele Shale (Upper Cretaceous)</b> —Dark-gray to black fissile shale with interbedded dark-brown-weathering, fine-grained, gray to brown sandstone. Some sandstone beds contain bluish-gray calcareous concretions and thin beds of bluish-gray limestone. Thickness 700–820 m (2,300–2,700 ft)
Кр	<b>Pierre Shale (Upper Cretaceous)</b> —Medium- to dark-gray and light-brown fossiliferous shale; <i>Inoceramus</i> sp. and <i>Bacculites</i> sp. common (Hammond, 1949). Siliceous limestone concretions occur in the upper part of the basal section; poorly exposed, found only along escarpment beneath the White River Formation in southeast corner of map area. Thickness of exposure in quadrangle approximately 90 m (295 ft)
<u>K6</u>	Niobrara Formation (Upper Cretaceous)—Poorly exposed shale, chalk, and limestone; forms subtle, rounded ridges. Upper 4–5 m (13–16 ft) consists of chalky fossiliferous light-yellow to light-orange limestone; breaks into lenticular, platy fragments, generally less than 25 cm (10 in) across and less than 5 cm (2 in) thick. Upper limestone overlies approximately 85–90 m (279–295 ft) of poorly exposed gray to light-reddish orange shale, interbedded with thin limestone beds, generally less than 0.3 m (1 ft) in thickness. Lower section, equivalent to the Fort Hays Limestone throughout the Denver Basin, consists of approximately 6 m (20 ft) of gray blocky limestone with abundant <i>Inoceramus deformis</i> . Fragments of <i>Platyceramus</i> are common throughout. Total thickness approximately 167 m (548 ft)
Kf	<b>Frontier Formation (Upper Cretaceous)</b> —Dark-gray to black shale with interbedded thin, lenticular, tan to gray sandstones and thin bentonite beds. Top of the formation grades to sandy shale. Thickness 163 m (550 ft)
Kmt	<b>Mowry Shale, Muddy Sandstone, and Thermopolis Shale (Upper and Lower Cretaceous)</b> —Mowry Shale is a resistant, gray to brown, hard, brittle, siliceous, platy shale with fossil fish scales; weathers light gray with abundant iron-oxide staining along fractures and exposed edges. Overlies thin light-brown, fine- to medium-grained sandstone speckled with dark grains. Sandstone underlain by gray to dark-brown, variably sandy siltstone. Thickness approximately 71 m (234 ft). Muddy Sandstone is a white, buff, gray, fine- to very fine grained sandstone with common salt-and-pepper appearance that is more noticeable on fresh surfaces; weathered surfaces stained with rusty to yellow-brown iron oxide 9–15 m (30–49 ft) thick. Thermopolis Shale is a dark-gray to black, recessive, fissile shale; locally bentonitic, fossilferous. Contains iron carbonate concretions near the base; 30 m (98 ft) thick
Ксч	<b>Cloverly Formation (Lower Cretaceous)</b> —Fine- to medium-grained, locally coarse- grained pebble conglomerate near base. Color varies from white, light-tan, to buff; weathered surfaces commonly stained brown, rusty-brown to yellow, and reddish- pink, locally black. Massive bedding as well as dune- and ripple-scale cross-beds common: prominent ridge-former: 15–23 m (50–75 ft) thick
Jm	<b>Morrison Formation (Jurassic)</b> —Shale, siltstone, limestone, and thin sandstone lenses. Upper part consists of approximately 69 m (225 ft) of variegated gray, greenish-gray, and light-brown calcareous shale; weathered surfaces are reddish-purple, maroon, green, and pinkish-gray. Approximately 15 m (50 ft) of interbedded brown to gray cherty limestone and calcareous shales and siltstones at base. Contact with the underlying Sundance Formation is gradational; contact mapped at decreased color variegation. Thickness approximately 84 m (276 ft)
Js	<b>Sundance Formation (Jurassic)</b> —Interbedded shale, siltstone, limestone, and sandstone. Upper 17 m (57 ft) mostly light-greenish-gray, light-pink, drab, calcareous, moderately well laminated shales and siltstones. Middle zone is 4 m (14 ft) of fossiliferous gray-green, laminated, calcareous shale. Lower 17 m (57 ft) consists of light-red, pink, orange, fine- to medium-grained, well-sorted sandstone; massive, locally cross-bedded, forms prominent ridges in east-central portion of quadrangle; sharp contact with overlying intercalated zone; sharp color change at
KJs	contact with underlying red siltstones of the Chugwater Formation. Approximately 38 m (117 ft) thick Cloverly, Morrison, and Sundance formations, undivided (Lower Cretaceous and
Τκc	<ul> <li>Jurassic)</li> <li>Chugwater Formation (Triassic)—Interbedded siltstone, shale, fine-grained sandstone, and claystone, separated by middle limestone unit. Upper 136 m (445 ft) consists of red and reddish-brown siltstones, shales, and claystones. Middle unit consists of approximately 3 m (10 ft) of reddish-brown shaly limestone, underlain by relatively thin purplish-gray, massive, finely crystalline limestone, generally less than 0.3 m (1 ft) thick. Lower red beds sequence of orange, rusty-brown to reddish-brown, mostly calcareous shales, siltstones, and fine-grained friable sandstones; sandstone grades into approximately 1 m (3 ft) of light-gray to pink calcareous sandstone and limestone at contact with underlying formations. Total thickness approximately 272 m (892 ft; Hammond, 1949)</li> </ul>
M T⊧Pu	lesozoic and Paleozoic Goose Egg and Chugwater formations, undivided (Triassic and Permian)
Pge	aleozoic Goose Egg Formation (Permian)—Gray to purple, thin-bedded, sparsely fossiliferous
PPc	<ul> <li>Inmestone locally interbedded with red siltstone and thin gypsum laminations. Wavy outcrops resembling algal structures common. Thickness 3–9 m (10–30 ft)</li> <li>Casper Formation (Permian and Pennsylvanian)—Purplish-gray, micritic to medium-grained, locally fossiliferous limestone and dolomite with lesser interbeds of buff to tan, very fine to coarse-grained, subarkosic siltstone, cross-bedded sandstone, and</li> </ul>
Open File	conglomerate. Approximately 46–280 m (151–919 ft) thick <b>NOTICE FOR OPEN FILE REPORTS PUBLISHED BY</b> <b>THE WYOMING STATE GEOLOGICAL SURVEY (WSGS)</b> Reports are preliminary and usually require additional fieldwork and/or compilation and

## **EXPLANATION**

**DESCRIPTION OF MAP UNITS** 

Granite and composite dikes-Granite dikes are fine- to coarse-grained, pink; composed of potassium feldspar, plagioclase, quartz, hornblende, and biotite;

percent volume of minerals varies from outcrop to outcrop; locally pegmatitic. Feldspar is commonly sericitized; occasionally exhibits minor muscovite and

chlorite with trace amounts of zircon and hematite. Width ranges 1–15 m (3–49 ft); typically trend north to northwest. Cross-cuts all units within the Maloin

Ranch pluton and Chugwater anorthosite. Composite dikes are fine- to mediumgrained, locally pegmatitic, light gray to pink; composed of granite intermingled

with mafic intrusions ranging from monzonite to ferrodiorite. Granitic

components primarily composed of potassium feldspar, quartz, and minor biotite; monzonite and ferrodiorite dominantly composed of coarse to

megacrystic plagioclase, biotite, and hornblende. Mafic portions generally occur as pillows intruded into the granitic magma with gradational to intermixed contacts. U-Pb zircon age of  $1,432.8 \pm 2.4$  Ma from monzodiorite dike (Frost

Red Mountain pluton, undifferentiated—Red-weathering, equigranular felsic rock

with hornblende evenly distributed amongst feldspar megacrysts. Locally hornblende contains meter-sized red-weathering patches of either fayalite or

hedenbergite. Dark-green on fresh surface. In thin section this unit can be subdivided into fayalite-monzonite, clinopyroxene-quartz-monzonite, and

biotite-hornblende-quartz monzonite (Anderson and others, 2001), but this is not

possible in the field. Cut by black, fine-grained, hornblende-quartz-monzonite

Granite-Several discrete varieties of granite exist within the Maloin Ranch

pluton. Porphyritic granite: coarse-grained, porphyritic, pink; composed of microcline-perthite, ferrohornblende, biotite, and quartz; typically exposed on ridges near bodies of monzosyenite and quartz syenite. Medium-grained

porphyritic granite: medium-grained, subequigranular; composed of

subequant microcline-perthite megacrysts, ferrohornblende, biotite, and up

to 35 percent modal quartz; gradational transition away from monzosyenite

and quartz syenite. Southern porphyritic granite: coarse-grained,

porphyritic; composed of tabular, zoned microcline; resembles portions of

porphyritic unit composed of feldspar megacrysts hosted in a fine-grained,

monzonitic matrix. Feldspar megacrysts (0.5-4 cm [0.2-1.6 in]) include

both microperthite and plagioclase, are typically subhedral to euhedral, randomly oriented, and occasionally exhibit prominent twinning. Monzonitic matrix composed of plagioclase, microperthite, and minor

quartz (no more than 5 percent), with clots of inverted pigeonite and

clinopyroxene. Majority of the area mapped as porphyritic monzonite

includes interlayered fine-grained monzonite, biotite gabbro, porphyritic

monzonite, and monzosyenite. Contacts between porphyritic monzonite

with fine-grained monzonite and monzosyenite are sharp; commonly

1.2 in]) are primarily composed of perthite and lesser plagioclase, with

partial replacement by microcline; myrmekite is common along megacryst grain boundaries. Ferromagnesian minerals in matrix include ferroaugite,

inverted pigeonite, and fayalite, which occur as clots surrounded by green

ferrohornblende and grunerite. Trace minerals include ilmenite, zircon, and

apatite; quartz content variable. Forms low, spheroidal outcrops. Contact with overlying quartz syenite and porphyritic granite gradational;

underlying fine-grained monzonite is typically interlayered with sharp

Fine-grained monzonite—Fine- to medium-grained, equigranular to locally

porphyritic monzonite composed of interlocking plagioclase, microperthite,

ferroaugite, inverted pigeonite, biotite, and quartz; quartz content does not exceed 5 percent; localized, weak magmatic foliation defined by alignment

of feldspar phenocrysts. Commonly exhibits deep-red iron staining; gray on fresh surfaces. Porphyritic variants dominated by 2-3 cm (0.8-1.2 in) feldspar megacrysts with minor ferromagnesian constituents in the matrix.

Includes fine- to medium-grained ferrodiorite dikes and inclusions that

occur along basal contact with Chugwater anorthosite; composed of plagioclase, augite, inverted pigeonite, composite ilmenite-titanomagnetite,

Monzosyenite—Orange-weathering rock consisting of interlocking alkali-

Porphyritic monzonite-Brown-weathering rock consisting of interlocking alkali-feldspar megacrysts in a finer-grained matrix of plagioclase, alkali

feldspar, olivine, and hedenbergite. Rarely contains quartz (Frost, in press a,

Ferromonzonite—Fine-grained, dark-brown-weathering rock consisting of interlocking feldspars. Proportions of feldspars in this rock range from

mainly plagioclase to an equal proportion of plagioclase and highly

exsolved alkali feldspar. Ferromagnesian minerals present include

ferroaugite, olivine, and sporadic inverted pigeonite (Frost, in press a, b)

Buttes granite—Very coarse grained granite characterized by megacrystic,

rounded alkali feldspar. Fine-grained, recrystallized granite with quartz

ribbons occurs in north-south-trending shear zones that cut the Buttes

granite. Locally intruded by fine-grained granitic dikes (Mitchell, 1993)

Greaser intrusion—Interlayered intrusion consisting of ferrodiorite cumulate

and olivine ferrodiorite; north-south-striking foliation defined by alignment

of pyroxene- and oxide-rich horizons with plagioclase lamination. Southern portion of intrusion dominated by fine- to medium-grained (0.2-1 cm [0.8-

0.4 in]) ferrodiorite with localized oxide-rich zones. Ferrodiorite composed

of plagioclase, inverted pigeonite, augite, and orthopyroxene, with ilmenite, magnetite, apatite, and rare olivine. Northern portion has prominent ridges

of olivine ferrodiorite; composed of sodic plagioclase, olivine, augite, and inverted pigeonite, with minor ilmenite, magnetite, and apatite (Mitchell,

foliated troctolite to leucotroctolite with lesser anorthosite, leucogabbro,

and oxide-rich gabbro; variably equigranular to megacrystic. Western part

and eastern margin of intrusion have interlayered to gradational boundaries

with series of subparallel anorthosite bodies; anorthosites are of the Poe Mountain and Chugwater anorthosite plutons. The Strong Creek ore body is

the most prominent oxide-rich gabbro body hosted within the troctolite.

Strong Creek troctolite and Greaser intrusion cut by numerous granitic and

mafic dikes; mafic dikes composed of olivine gabbronorite, ferrodiorite,

Snow Creek anorthosite—Medium-grained, poorly exposed, inequigranular

anorthosite composed of abundant subhedral labradorescent feldspar (An<sub>47-56</sub>).

Distinguished from the Chugwater anorthosite by lack of magnetite and olivine,

and local occurrences of quartz. Exhibits sparse clots of ferromagnesian

minerals, including augite, inverted pigeonite, and minor actinolite. Alteration

common: calcite and muscovite after plagioclase, chlorite and actinolite after

pyroxene, and titanite and rutile after ilmenite. Age constrained to between

Upper leucogabbroic layered zone—Consists of plagioclase (An40-55), augite,

inverted pigeonite or orthopyroxene, olivine, magnetite, ilmenite, and

apatite. Compositional layering, marked by changes in abundance of

plagioclase and ferromagnesian minerals, present throughout; anorthosite

layers generally thinner than the leucogabbroic layers. Igneous textures,

mostly tabular plagioclase with post-cumulate pyroxene, olivine, or Fe-Ti

upper layer. Compositional layering is common, but anorthositic layers are

orthopyroxene or locally pigeonite, minor olivine, ilmenite, magnetite, and

apatite. Top of the upper anorthositic layered zone is marked by an

anorthosite layer that is greater than 60 m (197 ft) thick. The upper

anorthositic layered zone contains strong layering, abundant igneous

textures and local layers of leucogabbro. Black to gray, fine-grained

recrystallized plagioclase neoblasts provide evidence for deformation

Middle anorthositic layered zone—Contains fewer leucogabbro layers, less

Lower anorthositic layered zone—Contains no layers of leucogabbro and only

Leucotroctolite-Medium- to coarse-grained rock consisting of interlocking

black plagioclase with interstitial olivine. Locally may contain significant

abundances of magnetite and ilmenite. Leucotroctolite occurs as intrusions

into the anorthosite layered zone of the Poe Mountain anorthosite (Ypm1

and Ypm2) and as inclusions in the Ypm2; at least two separate intrusion

periods have been defined. Large inclusions also occur in the Sybille

intrusion. It is possible that the inclusions represent the roof of the Poe

Poe Mountain Anorthosite, undifferentiated—Well-layered anorthositic complex

with interlayered anorthosite, leucogabbro, leucotroctolite, and olivine

leuconorite. Contains plagioclase, clinopyroxene, inverted pigeonite, olivine,

orthopyroxene, ilmenite, magnetite, and apatite with minor constituents of

biotite, pyrrhotite, zircon, quartz, and alkali feldspar. Dated to  $1,434.4 \pm 0.4$  Ma

local remnants of igneous fabrics; deformation fabrics are widespread,

consisting mostly of fragments of black plagioclase in a sea of gray

isotopic changes (Scoates and others, 1996; Frost, in press a, b)

plagioclase neoblasts (Frost, in press a, b)

Mountain intrusion (Frost, in press a, b)

(Frost and others, 2010; Frost, in press a, b)

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abundant igneous textures, and more abundant deformation textures than

the upper layer. Boundary between the middle anorthositic layered zone and

lower anorthositic layered zone is cryptic and based on geochemical and Sr

thicker and more abundant than in the upper leucogabbroic layered zone.

Igneous textures dominated by tabular plagioclase (Frost, in press a, b)

Upper anorthositic layered zone—Consists of plagioclase (An<sub>40-55</sub>), augite,

Lower leucogabbroic layered zone—Contains the same mineralogy as the

olivine ferrodiorite, and monzodiorite (Mitchell, 1993)

 $1,434.4 \pm 0.4$  Ma and  $1,432.8 \pm 2.4$  Ma (Frost and others, 2010)

oxides are prevalent (Frost, in press a, b)

Strong Creek troctolite—Coarse- to very coarse grained (5–10 cm [2–3.9 in])

feldspar megacrysts. Ferromagnesian minerals, fayalite, hedenbergite, and rarely hornblende occur in interstices between the megacrysts. Contains up

contacts but is locally gradational to intermixed (Kolker, 1989)

Monzosyenite—Coarse-grained, deep red-brown, two-feldspar cumulate composed of interlocking megacrystic feldspar in matrix of finer-grained ferromagnesian minerals, plagioclase, and quartz; magmatic foliation defined by alignment of mafic minerals. Feldspar megacrysts (1-3 cm [0.4-

Porphyritic monzonite-Coarse-grained, red-brown to gray, massive,

the Sherman batholith (Kolker, 1989)

interlayered (Kolker, 1989)

and apatite (Kolker, 1989)

to 5 percent quartz (Frost, in press a, b)

Sybille intrusion

Strong Creek complex

Poe Mountain anorthosite

(Frost, in press a, b)

Laramie Anorthosite Complex (Mesoproterozoic)

and others, 2010)

Maloin Ranch pluton

Ypm2

Ypmlt

cooperation.

analysis; they are meant to be a first release of information for public comment and review. The

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## **OPEN FILE REPORT 2021-5** Rock River 1:100,000-scale **Bedrock Geologic Map**

	ilmenite, and titanomagnetite; biotite only present with olivine; t sulfides include pyrrhotite, pentlandite, and chalcopyrite. Compositive interlayering throughout unit with anorthosite of the upper anortho
Yca3	layered zone defined by varying abundance of ferromagnesian mine. Forms topographic lows; poorly exposed (Lindsley and others, 2010) Upper anorthositic layered zone (King Mountain anorthosite)—Medi
	grained, blue-gray, subequigranular to inequigranular anortho Composed of tabular labradorescent plagioclase phenocrysts (2–3 [0.75–1.2 in]) with rare megacrysts (larger than 5 cm), inverted pigeor
	contains trace quartz and secondary muscovite, epidote, and serie Plagioclase phenocrysts contain inclusions of magnetite, ilmenite, bio and rutile; inverted pigeonite only present in upper stratigraphic level
	unit. Distinctive lamination and magmatic foliation defined by alignmer plagioclase phenocrysts. Age constrained to $1,435.95 \pm 0.687$ Ma (Frost others, 2010; Lindsley and others, 2010)
Ycagm	Middle leucogabbroic layered zone—Medium- to coarse-grained, dark-blu black, subequigranular to inequigranular, locally megacrystic gabb anorthosite. Composed of anhedral to tabular plagioclase (80–90 perce
	iron-rich augite (up to 15 percent), and orthopyroxene; minor ph include olivine, ilmenite, and titanomagnetite; biotite only present olivine; trace sulfides include pyrrhotite, pentlandite, and chalcopy Compositional interlayering throughout unit with anorthosite of the min
	anorthositic layered zone defined by varying abundance of ferromagne minerals. Forms topographic lows; poorly exposed; thickest of Chugwater leucogabbro units (Lindsley and others, 2010)
Yca2	Middle anorthositic layered zone—Medium- to coarse-grained, dark-blu dark-gray, subequigranular to inequigranular, locally megacry anorthosite. Composed of anhedral to tabular labradorescent plagico
	rutile, accessory muscovite (less than 5 percent); secondary biotite, chlo sericite, epidote, and muscovite present. Plagioclase phenocrysts con inclusions of magnetite, ilmenite, biotite, and rutile; white to light-
	plagioclase neoblasts present on phenocryst grain boundaries due to h temperature deformation. Weak magmatic foliation defined by alignmer plagioclase phenocrysts; compositional layering present throughout defined by abundance of ferromagnesian minerals; forms topographic hi
	Contains characteristic intrusions of leucotroctolite; leucotrocto composed of light-gray plagioclase, olivine, augite, orthopyroxene, accessory biotite (1–2 percent), ilmenite, titaniferous magnetite, and t
	pyhrrotite, pentlandite, and chalcopyrite. Leucotroctolite bodies typically 2–20 m (6.5–65.6 ft), and both cut and lie parallel to regi- layering; contacts with anorthosite are sharp (Frost and others, 20 Lindsley and others, 2010)
Ycagl	<b>Lower leucogabbroic layered zone</b> —Coarse-grained to megacrystic, dark- to black, subequigranular to inequigranular leucogabbro. Composed tabular plagioclase (80–90 percent), iron-rich augite (up to 15 percent).
	orthopyroxene; minor phases include olivine, ilmenite, and titanomagne biotite only present with olivine; trace sulfides include pyrrho pentlandite, and chalcopyrite. Compositional interlayering throughout
	abundance of ferromagnesian minerals. Forms topographic lows; po exposed (Lindsley and others, 2010)
Yca1	Lower anorthositic layered zone—Coarse-grained to megacrystic, dark-g inequigranular to semiequigranular anorthosite composed of tabe labradorescent plagioclase phenocrysts. Minor mineral constituents incl augite, low-Ca pyroxene, ilmenite, magnetite, and local quartz. Oli
	present where the anorthosite has been intruded by troctolite; trocto inclusions are medium-grained to megacrystic, undeformed, compose olivine (up to 50 percent), plagioclase, minor orthopyroxene, biotite, accessory ilmenite and titaniferous magnetite: exhibits sharp bound
	when injected; forms recessive outcrops. Lower anorthositic layered zor distinctly stratified; compositional layering defined by varying abundation of ferromagnesian minerals. Age constrained between $1,435.4 \pm 0.5$ Ma $1.435.21 \pm 0.88$ Ma (Scoates and Chamberlain, 1995; Frost and other structure) and the structure of the stru
Ycaf	2010; Lindsley and others, 2010; Frost and others, 2013) Fractured anorthosite—Poorly exposed anorthosite with sporadic troctor
	that contains mostly plagioclase with minor pyroxene. Plagioclase polygonal and shows effects of extreme grain-size reduction due to h temperature deformation, possibly in the presence of magma. Loca
	fractured appearance results from numerous intersecting structural lithologic boundaries in medium-grained, gray, massive to foli anorthosite composed of plagioclase, disseminated olivine, and m magnetite and ilmenite (Newhouse and Hagner, 1957; Lindsley and oth
	2010). Troctolite is medium grained to megacrystic, undeformed, compo of olivine (up to 50 percent), plagioclase, minor orthopyroxene, biotite, accessory ilmenite and titaniferous magnetite. Troctolite commonly oc
	boundaries when injected; forms recessive outcrops (Frost and others, 20 Lindsley and others, 2010)
Ycact	to anhedral, recrystallized anorthosite. Quartz content does not exceed percent; accessory minerals include biotite, clinopyroxene, ilmenite, magnetite. Plagioclase laths vary widely in size, reaching 6 cm (2.6 ir length. Weathers pink-red. Outcrops display more deformation than o units within the Chugwater anorthosite. Age constrained to 1,435.25 ± Ma (Frost and others, 1996; Lindsley and others, 2010)
Ycau	<b>Chugwater anorthosite, undivided</b> —Coarse-grained to megacrystic, d gray, inequigranular to semiequigranular massive anorthosite compose labradorescent plagioclase with minor augite, low-Ca pyroxene, oliv
	ilmenite, magnetite, and local quartz. Occupies lowest stratigraphic posi in the Chugwater anorthosite pluton and is separated from lo anorthositic layered zone by structural boundary (Lindsley and oth 2010): both units are petrographically and compositionally identical
	undivided Chugwater anorthosite lacks traceable layering and lamina and exhibits evidence of different structural and deformational history layered anorthosite zones (Lindsley and others, 2010). Age constrained between 1.425.7 + 1.1 Ma and 1.425.5 + 0.3 Ma (Fragt and others, 2010)
Yau	Anorthosite, undifferentiated—Undifferentiated anorthositic, leucogabbi gabbroic, and troctolitic units of the Snow Creek, Poe Mountain, and Chugw anorthosite plutons
Ysmc	Mule Creek granite, associated with Sherman batholith (Mesoproterozoic)—Coa grained, orange-red granite composed of potassium feldspar, plagioclase, qua hambles de forme units high the second formulate Composed has been been been been been been been bee
	weathers to a deep, orange-red grus. Opaque phases include ilmenite, magne chalcopyrite, and pyrrhotite; accessory phases include zircon, apatite, and 1 fluorite. Composed of approximately one percent ferrodiorite pods and dikes (F and others, 2001; Frost and others, 2002). Age constrained to 1,437.7 $\pm$ 2.4 (Frost and others, 2002). Locally intruded by Devonian kimberlitic sills and d (Hausel and others, 2003)
Xkd	<b>Kennedy dike swarm (Paleoproterozoic)</b> —Diabasic amphibolite, plagioclase porpl amphibolite, and altered peridotite dikes of the Kennedy dike swarm. Alte peridotite dikes are dark-green, medium-grained actinolite, talc, and chlorite, loc
	containing carbonate. In contact aureole of Sybille intrusion, may contain assemblage olivine, orthopyroxene, chlorite, and plagioclase. Diabase amphibo dikes are speckled greenish-black metadiabase. In low-strain areas, orig
	to hornblende and plagioclase, with small garnets that have nucleated on boundary between hornblende and plagioclase. Within a kilometer of contact Sybille intrusion, dikes have been altered to pyroxene-hornfels with assemb
	(75–85 percent). Plagioclase porphyry amphibolite dikes are dark-greenish-bl. composed of hornblende and plagioclase; plagioclase phenocrysts are 1–5 cm (0. in). Generally considered oldest dike type based on crosscutting relationships.
Wlgr	<ul> <li>constrained to 2,010 ± 10 Ma (Cox and others, 2000)</li> <li>Granite and granite gneiss, undifferentiated (Neoarchean)—Pink, medium- to coa grained, massive to highly foliated granitic gneiss. Biotite is generally promin</li> </ul>
	and muscovite might be present locally. Includes large, partially melted inclu- within the Sybille intrusion. Age is poorly constrained. Two ages around 2.62 (Verts and others, 1996; Snyder and others, 1998) suggest that some portions p date the Elmers Rock greenstone belt although Snyder (1984) contends the set
Wk	<ul> <li>Microcline augen granite gneiss, associated with Squaw Rock gra</li> </ul>
	gneiss. Microcline phenocrysts, $2.5-7.5$ cm (1–3 in) in diameter, make up 10 to percent of the rock; accessory sphene is present as both fine-grained, subhedra anhedral grains parallel to the foliation, and as coarse-grained, anhedral gr
	other Archean granites and granitic gneisses are locally gradational to cross-cutt Age constrained by U-Pb dating to $2,641 \pm 1.2$ to $2,618.7 \pm 1.2$ Ma (Verts others, 1996)
Wem	Elmers Rock greenstone belt (Neoarchean) Marble—Buff-weathering to dark-brown, fine- to very coarse grained man
	(previously called the Bluegrass Creek Metamorphic Suite). Locally grades calc-silicate rocks. Varieties include white dolomite and tremolite-dolon white to gray, very coarse grained calcite marble, well-layered clear-bro calcite marble, and white-green to brown spotted dolomite-calcite ma (Snyder, 1984)
Weps	<b>Pelitic schist</b> —Quartz-biotite-muscovite schist. Commonly has kayanite-sillimar garnet assemblage outside contact aureole of the Sybille intrusion. Within aureole, contains andalusite and cordierite. May contain streaks of granitic 1 (Snyder 1984)
Wefb	<b>Felsic biotite gneiss</b> —Speckled gray feldspar-quartz-biotite gneiss and sch possibly derived from clay-bearing silts, sands, and gravels (Snyder, 1984)
Wea	Amphibolite—Medium-grained, green to black, layered amphibolite. In low-st areas, pillows may be preserved. Commonly interlayered with calc-sili rocks. In the contact aureole of the Sybille intrusion the amphibolite has b
	converted to a fine-grained brown hornfels with the assemblage orthopyroxo clinopyroxene-hornblende-plagioclase (Snyder, 1984)
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