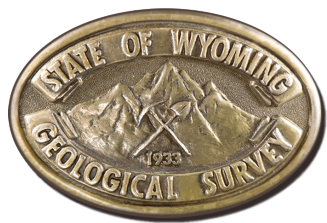


Interpreting the past, providing for the future

Precambrian Basement Map of Wyoming: Structural Configuration

Wyoming State Geological Survey

Open File Report 2022-5
Revised February 2023



Wyoming State Geological Survey

Erin A. Campbell, Director and State Geologist



Precambrian Basement Map of Wyoming: Structural Configuration

With contributions from:

James A. Amato	Derek T. Lichtner	James R. Rodgers
Erin A. Campbell	Andrea M. Loveland	Rachel N. Toner
Tomáš Gracias	David W. Lucke	Seth J. Wittke
Richard W. Jones	Suzanne C. Luhr	
Natali A. Kragh	Ranie M. Lynds	

Layout by James R. Rodgers

Open File Report 2022-5
Wyoming State Geological Survey
Laramie, Wyoming: 2023

Open File Reports are preliminary and usually require additional fieldwork and/or compilation and analysis; they are meant to be a first release of information for public comment and review. The Wyoming State Geological Survey welcomes any comments, suggestions, and contributions from users of this information.

Citation: Wyoming State Geological Survey, 2022, Precambrian basement map of Wyoming—Structural configuration: Wyoming State Geological Survey Open File Report 2022-5, 8 p., 1 pl., scale 1:500,000, <https://doi.org/10.15786/21183787>. (Revised 2023.)

Table of Contents

Abstract	1
Introduction	1
Methods	1
Results	3
Acknowledgments	4
References	5

ABSTRACT

The Precambrian basement map of Wyoming, by D.L. Blackstone, Jr. (1993a), has been a primary and authoritative reference for Wyoming geology since its publication. However, the utility of paper maps has abated in recent decades, and the original dataset of wells that served as the backbone to the map was never published. To provide a similarly useful map that accommodates the increasing use of digital geospatial technology, the Wyoming State Geological Survey (WSGS) revised the Precambrian basement map of Wyoming. Well logs, seismic lines, cross sections, and digital elevation models were used to refine and reinterpret the structure of the Precambrian rocks throughout the state. All reference and WSGS-generated data, as well as associated metadata, are organized and publicly available in a U.S. Geological Survey (USGS) standardized geodatabase schema, available from the [WSGS website](#) and on the [Interactive Oil and Gas Map of Wyoming](#).

INTRODUCTION

Precambrian basement structural configuration, both at the surface and in the subsurface, is a fundamental component for understanding the geology of a region. Igneous and metamorphic “basement” rocks—generally crystalline rocks that underlie stratified sedimentary cover—record Earth’s earliest geologic processes that occurred throughout the Precambrian, ending about 541 million years ago.

In Wyoming, Precambrian rocks are exposed at the surface in basement-cored mountain ranges. Yet in the adjacent basins, these rocks are well below the surface, covered by a thick sequence of Phanerozoic strata. Even buried by thousands of feet of sedimentary rock, the basement influences tectonism and faulting; basin geometry; accumulation, preservation, and erosion of sediment; and hydrocarbon and mineral deposits—resulting in geology that can be favorable for exploration of natural resources. Understanding the structural configuration of the basement is important for governmental agencies that support development of natural resources as well as for scientific studies involving continent evolution and reconstruction.

The driving force behind this study is ongoing WSGS research into understanding the occurrence and distribution of critical minerals throughout Wyoming. Critical minerals are minerals and elements deemed essential to U.S. national security and the economy. Wyoming hosts substantial concentrations of many of these minerals, in part due to the wide variety of geologic environments present throughout the state. Many critical minerals in Wyoming are either found in, or originate from, Precambrian igneous and metamorphic rocks. An accurate and documented spatial analysis of the elevation and structure of Wyoming’s Precambrian basement is therefore imperative to critical-mineral exploration and development within the state.

Previous work by Blackstone (1993a) utilized well data, gravity and magnetic surveys, cross sections, seismic reflection data, and other information to publish a structure contour map of the basement at the scale of 1:1,000,000. With little new data but some new interpretations and a consistent thousand-foot contour interval, the WSGS preliminarily revised Blackstone’s map as plate 2 of Lynds (2013).

This study more thoroughly revises and updates the Precambrian basement map of Wyoming, focusing on basement elevation and faulting. In the 30 years since the Blackstone work was completed, additional oil and gas wells with associated well logs have been drilled, and new geophysical surveys and cross-section interpretations have been generated. As such, this map uses previous mapping and new data to reinterpret the elevation, relative to mean sea level, of Precambrian basement rock and associated structures, statewide, at the scale of 1:500,000.

METHODS

A primary objective of this study was to compile and verify an exhaustive well dataset to be used in interpreting the Precambrian basement structure and elevation. The final well dataset attempted to include wells shown on Blackstone’s (1993a) map. Of the 272 wells originally noted on the 1993 map, 167 wells were confidently associ-

ated with a current Wyoming Oil and Gas Conservation Commission (WOGCC) API number, a unique number assigned to every oil or gas well drilled in the United States. The remaining 105 of Blackstone's (1993a) wells were either unable to be confidently identified, were completed to depths not useful to the current interpretation, or were omitted due to their spatial proximity to another well with a more confident or relevant formation interpretation. Beyond the Blackstone (1993a) wells, 309 additional wells were identified and incorporated from the WOGCC (2022) database using formation geologic marker and bottom formation queries and legible well logs, and 25 wells were added from Flawn (1967) and Flawn and others (1967).

Wells drilled to or through the Precambrian with accurate Precambrian elevation interpretations are ideal guides, yet they are rare in Wyoming since oil and gas reservoirs are almost always contained within the overlying Phanerozoic strata. In areas with scarce Precambrian well data, it was therefore necessary to include wells completed in Paleozoic units, which are much more common.

All wells included in the dataset were subjected to quality control efforts to confirm the following: location accuracy, relative to permitted location (WOGCC, 2022); datum elevation accuracy, relative to a 10-meter digital elevation model and datum elevation noted on well-log headers or completion reports (U.S. Geological Survey, 2009; WOGCC, 2022); and formation interpretation accuracy, relative to formation name, fault intercept, and depth. Formation elevation relative to mean sea level was calculated by subtracting the interpreted measured formation depth from the datum of the geophysical well log (usually kelly bushing elevation, rarely ground level or drilling floor elevation). The resulting dataset contains 501 wells used as guides in contouring Wyoming's Precambrian basement.

To generally constrain the basement elevation from wells that did not reach the Precambrian, the thickness of the relevant Paleozoic unit or units was estimated and added to the measured depth of the well. The thickness of Wyoming's Paleozoic units varies significantly over a large areal extent. Thickness estimations referenced type logs provided in Lynds (2013) and local to regional studies, especially including Fisher (1906), Stipp (1947), Anderman (1956), Berg (1956), Burk (1956), Faulkner (1956), McCrae (1956), Mills (1956), Peterson (1956), McCoy (1958), Beikman (1962), Martin (1965), Thomas (1965), Keefer and Van Lieu (1966), Sonnenberg (1985), LeFebvre (1988), Love and others (1993), and Macke (1993). Many of these include basin- and unit-specific isopach maps.

To assist with Precambrian structural interpretation, published seismic lines, cross sections, geologic maps, and structure contour maps were consulted. Applicable data were georeferenced to ensure spatial accuracy and attributed as data sources accordingly, following Geologic Map Schema (GeMS) standards (U.S. Geological Survey National cooperative Geologic Mapping Program, 2020).

Referenced seismic interpretations and cross sections include Skeen and Ray (1983), Basham and Martin (1985), Brittenham and Tadewalk (1985), Ray and Keefer (1985), Sonnenberg (1985), Stone (1985a, 1985b, 1987, 2004), Blackstone (1986), LeFebvre (1988), Besse (1999), and Cook (2002).

Geologic maps, ranging in scale from 1:50,000 to 1:500,000, were used to identify basement-involved faulting and guide the Precambrian basement rock interpretation when no other information was available. These maps include Houston and others (1978), Love and Christiansen (1985), Ver Ploeg (1985), Houston and Karlstrom (1992), Ver Ploeg and Boyd (2002), Sutherland and Hausel (2003, 2004), Ver Ploeg (2004), Ver Ploeg and others (2004), Hunter and others (2005), McLaughlin and Ver Ploeg (2006), Hausel (2007), Sutherland (2007), Ver Ploeg and Boyd (2007), Wittke (2007), Jones and Gregory (2011), Jones and others (2011), McLaughlin and others (2011), Sutherland and others (2013), and Stafford and others (2021). In a few areas, the location of oil and natural gas fields were important for identifying geologic structure, as defined by Toner and others (2021).

Structure contour maps of Paleozoic and some Mesozoic units were relied upon heavily in many areas. These maps provided the general basin structure from which to estimate the basement rock elevation and were also useful for determining the type and extent of faulting. Maps used include Anderman and Ackman (1963), Keefer (1970), Heasler and Hinckley (1985), Blackstone (1986, 1991, 1993b), Sims and Day (1999), and Lichtner and others (2021).

In the northwest corner of the state, no Precambrian rocks are associated with the Yellowstone caldera. As such, the outermost track of the caldera, as defined by the related system of faults (Koch and others, 2011; Mauch and others, 2022), was used to delineate the extent of Precambrian structure in this region.

In a north–south trend extending from Jackson Hole to the Utah state border, deformation associated with the Sevier orogeny folded and faulted Phanerozoic strata. Because most wells in this overthrust belt area do not penetrate to the underlying Precambrian basement rock footwall, basement subsurface interpretations are limited.

Outcrop elevations, necessary for characterizing Precambrian rocks exposed at the surface, were derived from a 10-meter digital elevation model (U.S. Geological Survey, 2009) intersected with Precambrian polygons at the 1:500,000 scale from Love and Christiansen (1985).

Using all available aforementioned data sources, statewide thousand-foot-interval contours were developed to illustrate the top of the Precambrian basement elevation relative to mean sea level. The contours attempt to honor not only well and seismic data but also basement-involved faults and subsurface features that influence the Precambrian structure. Because digital modeling can misrepresent and obscure fine details needed in complex structural areas, all contours in this revision were hand-generated.

In many places, the original information presented on Blackstone (1993a) was considered the best available data, and the contour lines and faults changed very little. In other places, the original contouring was no longer sufficient to explain new subsurface information (usually from wells), and the contours were reinterpreted, sometimes significantly, to fit the data. Most of these interpretations were made without the insight of seismic data and will likely be changed in the future as more information becomes available.

For symbolization purposes, polygons were created from the contour lines and attributed with respective intervening contour intervals using the USGS GeMS toolbox. To ensure data integrity and connectivity, topology was run on the polygons and all errors corrected.

RESULTS

The updated 1:500,000-scale basement map is shown in plate 1 and is intended to supersede Blackstone (1993a). The WSGS requests that all users keep map scale in mind; this map is not intended to be used at scales larger than 1:500,000.

Spatial data used in the creation of plate 1 are compiled in a USGS standard GeMS level-3 compliant geodatabase schema (U.S. Geological Survey National Cooperative Geologic Mapping Program, 2020). The GeMS geodatabase is the true product of this study, and the WSGS intends for this map to hereafter be a digital publication.

The GeMS geodatabase includes:

- **ContactsAndFaults:** line feature class containing the map study area (state boundary), faults and associated fault type, and contour lines representing the top of the Precambrian basement (contour interval is 1,000 feet)
- **GenericPoints:** point feature class containing all oil and gas wells and interpreted point locations from seismic and cross section sources; includes elevation values relative to mean sea level for all points, in addition to API number, well datum, datum elevation, formation, and location information
- **MapUnitPolys:** polygon feature class that conforms spatially with **ContactsAndFaults** and attributed contour interval

- DataSources: table listing all data sources used by and attributed to geodatabase features
- FGDC-standard metadata .xml files accompany each feature class

The map is recognized as a work in progress, but converting to an all-digital format will simplify future refinements. Any additional data that could help refine contour lines or fault interpretations are welcome by WSGS geologists.

Plate 1 and the GeMS database are available for download through the [WSGS publication repository](#). The associated point, line, and polygon data can be viewed, along with additional downloadable well-attribute data, on the WSGS [Interactive Oil and Gas Map of Wyoming](#).

ACKNOWLEDGMENTS

This study was partially funded by the USGS National Geological and Geophysical Data Preservation Program, under award number G19AP00063.

Contributions from numerous geoscientists have been invaluable in the completion of this project that spanned many years. Contributors include: James A. Amato, Erin A. Campbell, Tomas Graciáš, Richard W. Jones, Natali A. Kragh, Derek T. Lichtner, Andrea M. Loveland, David W. Lucke, Suzanne C. Luhr, Ranie M. Lynds, James R. Rodgers, Rachel N. Toner, and Seth J. Wittke. WSGS contractor Natalie A. Kragh was integral in formation, fault, and preliminary contour interpretations, with oversight by Andrea M. Loveland and David W. Lucke. Data verification, in addition to contour and database finalization, were conducted by Ranie M. Lynds and Rachel N. Toner. Constructive reviews of various versions of plate 1 were provided by Erin A. Campbell, Derek T. Lichtner, Arthur W. Snoke, Patty M. Webber, and Seth J. Wittke. James R. Rodgers refined the dataset with comprehensive quality control reviews and assisted with report layout. Plate 1 map editing and layout were finalized by James A. Amato and Seth J. Wittke.

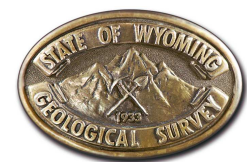
REFERENCES

- Anderman, G.G., 1956, Subsurface stratigraphy of the pre-middle Niobrara formations in the Green River Basin, Wyoming, *in* Wyoming stratigraphy—Subsurface stratigraphy of the pre-Niobrara formations in Wyoming, part 1: Wyoming Geological Association, p. 49–67.
- Anderman, G.G., and Ackman, E.J., 1963, Structure of the Denver-Julesburg Basin and surrounding areas, *in* Bolyard, W.W., and Katich, P.J., eds., Geology of the northern Denver Basin and adjacent uplifts: Rocky Mountain Association of Geologists, 14th field conference, 1963, p. 170–175, 2 pls., scale undetermined.
- Basham, W.L., and Martin, W.F., 1985, Seismic line across the Wind River Thrust Fault, Wyoming, *in* Gries, R.R., and Dyer, R.C., eds., Seismic exploration of the Rocky Mountain Region: Rocky Mountain Association of Geologists and Denver Geophysical Society, p. 59–66.
- Beikman, H.M., 1962, Geology of the Powder River Basin, Wyoming and Montana, with reference to subsurface disposal of radioactive wastes: U.S. Department of the Interior Geological Survey, Trace Elements Investigations Report 823, 85 p.
- Berg, R.R., 1956, Subsurface stratigraphy of the pre-Niobrara formations in the Shirley and Laramie basins, Wyoming, *in* Wyoming stratigraphy—Subsurface stratigraphy of the pre-Niobrara formations in Wyoming, part 1: Wyoming Geological Association, p. 77–83.
- Besse, R.E., Jr., 1999, Structural interpretation for the southern extent of the Rock Springs Uplift: Arlington, University of Texas at Arlington, M.S. thesis, 81 p., 6 pls.
- Blackstone, D.L., Jr., 1986, Foreland compressional tectonics—Southern Bighorn Basin and adjacent areas, Wyoming: Geological Survey of Wyoming [Wyoming State Geological Survey] Report of Investigations 34, 32 p., 2 pls., scale 1:250,000.
- Blackstone, D.L., Jr., 1991, Tectonic relationships of the southeastern Wind River Range, southwestern Sweetwater Uplift and Rawlins Uplift, Wyoming: Geological Survey of Wyoming [Wyoming State Geological Survey] Report of Investigations 47, 24 p., 2 pls., scale 1:250,000.
- Blackstone, D.L., Jr., 1993a, Precambrian basement map of Wyoming—Outcrop and structural configuration: Wyoming State Geological Survey Map Series 43, scale 1:1,000,000.
- Blackstone, D.L., Jr., 1993b, Overview of the Hanna, Carbon, and Cooper Lake basins, southeastern Wyoming: Geological Survey of Wyoming [Wyoming State Geological Survey] Report of Investigations 48, 20 p., 2 pls., scale 1:250,000.
- Brittenham, M.D., and Tadewalk, B.H., 1985, Detachment and basement involved structures beneath the Absaroka Range volcanics, *in* Gries, R.R., and Dyer, R.C., eds., Seismic exploration of the Rocky Mountain Region: Rocky Mountain Association of Geologists and Denver Geophysical Society, p. 31–43.
- Burk, C.A., 1956, Subsurface stratigraphy of the pre-Niobrara formations in the Wind River Basin, central Wyoming, *in* Wyoming stratigraphy—Subsurface stratigraphy of the pre-Niobrara formations in Wyoming, part 1: Wyoming Geological Association, p. 23–33.
- Cook, Lance, 2002, Geologic cross sections of the northern overthrust belt and Hoback Basin, Wyoming: Wyoming State Geological Survey Open File Report 02-3, 15 p., 1 pl.
- Faulkner, G.L., 1956, Subsurface stratigraphy of the pre-Niobrara formations along the western margin of the Powder River Basin, Wyoming, *in* Wyoming stratigraphy—Subsurface stratigraphy of the pre-Niobrara formations in Wyoming, part 1: Wyoming Geological Association, p. 35–42.
- Fisher, C.A., 1906, Geology and water resources of the Bighorn Basin, Wyoming: United States Geological Survey Professional Paper No. 53, 72 p., 1 pl.

- Flawn, P.T., ed., 1967, Wells penetrating basement in North America: American Association of Petroleum Geologists and U.S. Geological Survey, 707 p., 11 sheets.
- Flawn, P.T., Blackstone, D.L., Jr., Burwash, R.A., Caley, J.F., Cole, V.B., Dietrich, R.V., Foster, R.W., Guzman, E.J., Halbouty, M.T., Halsey, J.H., Hayes, W.C., Lyons, P.L., McKee, E.D., Masson, P.H., Sloss, L.L., Smith, M.B., White, W.S., Woodford, A.O., Woollard, G.P., and Young, Addison, 1967, Basement map of North America between latitudes 24° and 60° N: U.S. Geological Survey, scale 1:5,000,000.
- Hausel, W.D., 2007, Revised geologic map of South Pass City quadrangle, Fremont County, Wyoming: Wyoming State Geological Survey Map Series 74, scale 1:24,000.
- Heasler, H.P., and Hinckley, B.S., 1985, Geothermal resources of the Bighorn Basin, Wyoming: Geological Survey of Wyoming [Wyoming State Geological Survey] Report of Investigations 29, 27 p., 4 pls.
- Houston, R.S., and Karlstrom, K.E., 1992, Geologic map of Precambrian metasedimentary rocks of the Medicine Bow Mountains, Albany and Carbon counties, Wyoming: U.S. Geological Survey Miscellaneous Investigations Series Map I-2280, 22 p., scale 1:50,000.
- Houston, R.S., McCallum, M.E., King, J.S., Ruehr, B.B., Myers, W.G., Orback, C.J., King, J.R., Childers, M.O., Irwin Matus, Currey, D.R., Gries, J.C., Stensrud, H.L., Catanzaro, E.J., Swetnam, M.N., Michalek, D.D., and Blackstone, D.L., Jr., 1978, A regional study of Precambrian age in that part of the Medicine Bow Mountains lying in south-eastern Wyoming—With a chapter on the relationship between Precambrian and Laramide structure: Geological Survey of Wyoming [Wyoming State Geological Survey] Memoir 1, 167 p., 35 pls. (Reprinted from 1968.)
- Hunter, John, Ver Ploeg, A.J., and Boyd, C.S., 2005, Geologic map of the Casper 30' x 60' quadrangle, Natrona and Converse counties, Wyoming: Wyoming State Geological Survey Map Series 65, scale 1:100,000.
- Jones, N.R., and Gregory, R.W., 2011, Preliminary geologic map of the Shirley Basin 30' x 60' quadrangle, Carbon, Natrona, Albany, and Converse counties, Wyoming: Wyoming State Geological Survey Open File Report 11-8, scale 1:100,000.
- Jones, N.R., Gregory, R.W., and McLaughlin, J.F., 2011, Geologic map of the Bairoil 30' x 60' quadrangle, Carbon, Fremont, Sweetwater, and Natrona counties, Wyoming: Wyoming State Geological Survey Map Series 86, scale 1:100,000.
- Keefer, W.R., 1970, Structural geology of the Wind River Basin, Central Wyoming: U.S. Geological Survey Professional Paper 495-D, 35 p.
- Keefer, W.R., and Van Lieu, J.A., 1966, Paleozoic formations in the Wind River Basin: U.S. Geological Survey Professional Paper 495-B, 60 p.
- Koch, R.D., Ramsey, D.W., and Christiansen, R.L., 2011, Database for the Quaternary and Pliocene Yellowstone Plateau volcanic field of Wyoming, Idaho, and Montana: U.S. Geological Survey Data Series 551 (CD-ROM) [<http://pubs.usgs.gov/ds/551/>].
- LeFebre, G.B., 1988, Tectonic evolution of Hanna Basin, Wyoming—Laramide block rotation in the Rocky Mountain Foreland: Laramie, University of Wyoming, Ph.D. dissertation, 240 p., 2 pls.
- Lichtner, D.T., Edgin, M.G., and Rodgers, J.R., 2021, Greater Green River Basin formation tops database, structure and thickness contour maps, and associated well data, with a focus on potential continuous reservoirs: Wyoming State Geological Survey Open File Report 2021-1, 31 p.
- Love, J.D., and Christiansen, A.C., comps., 1985, Geologic map of Wyoming: U.S. Geological Survey, 3 sheets, scale 1:500,000. (Re-released 2014, Wyoming State Geological Survey.)
- Love, J.D., Christiansen, A.C., and Ver Ploeg, A.J., comps., 1993, Stratigraphic chart showing Phanerozoic nomenclature for the state of Wyoming: Geological Survey of Wyoming [Wyoming State Geological Survey] Map Series 41.
- Lynds, R.M., 2013, Geologic storage assessment of carbon dioxide (CO₂) in the Laramide basins of Wyoming: Wyoming State Geological Survey Technical Memorandum No. 3, 200 p., 20 pls.

- Macke, D.L., 1993, Cambrian through Mississippian rocks of the Powder River Basin, Wyoming, Montana, and adjacent areas: United States Geological Survey Bulletin 1917-M, 174 p.
- Martin, C.A., 1965, Denver Basin: American Association of Petroleum Geologists Bulletin, v. 49, no. 11, p. 1, 908–1,925.
- McCoy, M.R., 1958, Cambrian of the Powder River Basin: Wyoming Geological Association, 13th annual field conference, Guidebook, p. 21–24.
- Mauch, J.P., Stafford, J.E., and Wittke, S.J., 2022, Geology of Yellowstone map: Wyoming State Geological Survey, accessed June 2022, at <https://www.wsgs.wyo.gov/wyoming-geology/interactive-maps.aspx>.
- McCrae, R.O., 1956, Subsurface stratigraphy of the pre-Niobrara formations in the Julesburg Basin, southeastern Wyoming, *in* Wyoming stratigraphy—Subsurface stratigraphy of the pre-Niobrara formations in Wyoming, part 1: Wyoming Geological Association, p. 85–89.
- McLaughlin, J.F., Stafford, J.E., and Harris, R.E., 2011, Geologic map of the Lusk 30' x 60' quadrangle, Niobrara, Goshen, Converse, and Platte counties, Wyoming, and Sioux County, Nebraska: Wyoming State Geological Survey Map Series 82, scale 1:100,000.
- McLaughlin, J.F., and Ver Ploeg, A.J., 2006, Geologic map of the Newcastle 30' x 60' quadrangle, Weston and Niobrara counties, Wyoming, and Pennington and Custer counties, South Dakota: Wyoming State Geological Survey Map Series 71, scale 1:100,000.
- Mills, N.K., 1956, Subsurface stratigraphy of the pre-Niobrara formations in the Bighorn Basin, Wyoming, *in* Wyoming stratigraphy—Subsurface stratigraphy of the pre-Niobrara formations in Wyoming, part 1: Wyoming Geological Association, p. 9–22.
- Peterson, M.L., 1956, Subsurface stratigraphy of the pre-Niobrara formations along the eastern margin of the Powder River Basin, Wyoming, *in* Wyoming stratigraphy—Subsurface stratigraphy of the pre-Niobrara formations in Wyoming, part 1: Wyoming Geological Association, p. 43–48.
- Ray, R.R., and Keefer, W.R., 1985, Wind River Basin, central Wyoming, *in* Gries, R.R., and Dyer, R.C., eds., Seismic exploration of the Rocky Mountain Region: Rocky Mountain Association of Geologists and Denver Geophysical Society, p. 201–212.
- Sims, P.K., and Day, W.C., comps., 1999, Geologic map of Precambrian rocks of the Hartville Uplift, southeastern Wyoming, with a section on mineral deposits in the Hartville Uplift, by Terry Klein: U.S. Geological Survey Geologic Investigations Series I-2661, 30 p., scale 1:48,000.
- Skeen, R.C., and Ray, R.R., 1983, Seismic models and interpretation of the Casper Arch Thrust—Application to Rocky Mountain foreland structure, *in* Lowell, J.D., and Gries, Robbie, eds., Rocky Mountain foreland basins and uplifts: Rocky Mountain Association of Geologists, p. 99–124.
- Sonnenberg, S.R., 1985, Northwest Denver Basin/southeast Hartville Uplift, *in* Gries, R.R., and Dyer, R.C., eds., Seismic exploration of the Rocky Mountain Region: Rocky Mountain Association of Geologists and Denver Geophysical Society, p. 213–217.
- 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, Platte, and Laramie counties, Wyoming: Wyoming State Geological Survey Open File Report 2021-5, scale 1:100,000.
- Stipp, T.F., 1947, Paleozoic formations of the Bighorn Basin, Wyoming: Wyoming Geological Association, field conference in the Bighorn Basin, Guidebook, p. 121–130.
- Stone, D.S., 1985a, Geologic interpretation of seismic profiles, Big Horn Basin, Wyoming, Part I—East flank, *in* Gries, R.R., and Dyer, R.C., eds., Seismic exploration of the Rocky Mountain Region: Rocky Mountain Association of Geologists and Denver Geophysical Society, p. 165–174.

- Stone, D.S., 1985b, Geologic interpretation of seismic profiles, Big Horn Basin, Wyoming, Part II—West flank, *in* Gries, R.R., and Dyer, R.C., eds., *Seismic exploration of the Rocky Mountain Region: Rocky Mountain Association of Geologists and Denver Geophysical Society*, p. 175–186.
- Stone, D.S., 1987, Rocky Mountain transect—Wyoming: Littleton, Colo., DVD, version 2.0, compiled by Stone, D.S., and Hollberg, J.E., 2007.
- Stone, D.S., 2004, Rio thrusting, multi-state migration, and formation of vertically segregated Paleozoic oil pools at Torchlight field on the Greybull platform (eastern Bighorn Basin)—Implications for exploration: *The Mountain Geologist*, v. 41, no. 3, p. 119–138.
- Sutherland, W.M., 2007, Geologic map of the Sundance 30' x 60' quadrangle, Crook and Weston counties, Wyoming, and Lawrence and Pennington counties, South Dakota: Wyoming State Geological Survey Map Series 78, 26 p., scale 1:100,000.
- Sutherland, W.M., Durnan, J.A., and Johnson, J.F., 2013, Preliminary geologic map of the Centennial quadrangle, Albany County, Wyoming: Wyoming State Geological Survey Open File Report 13-5, scale 1:24,000.
- Sutherland, Wayne, and Hausel, W.D., 2003, Geologic map of the Rattlesnake Hills 30' x 60' quadrangle, Fremont and Natrona counties, Wyoming: Wyoming State Geological Survey Map Series 61, scale 1:100,000.
- Sutherland, W.M., and Hausel, W.D., 2004, Preliminary geologic map of the Saratoga 30' x 60' quadrangle, Carbon and Albany counties, Wyoming: Wyoming State Geological Survey Open File Report 04-10, version 1.1, 36 p., 1 pl., scale 1:100,000.
- Thomas, L.E., 1965, Sedimentation and structural basin development of Big Horn Basin: *American Association of Petroleum Geologists Bulletin* v. 49, no. 11, p. 1,867–1,877.
- Toner, R.N., Lynds, R.M., Stafford, J.E., and Lichtner, D.T., 2021, Interactive oil and gas map of Wyoming: Wyoming State Geological Survey, accessed June 2022, at <https://www.wsgs.wyo.gov/wyoming-geology/interactive-maps.aspx>.
- U.S. Geological Survey, 2009, National Elevation Data (NED), Digital Elevation Model for Wyoming 10 meter (published 20090101), accessed April 2018, at <https://www.usgs.gov/the-national-map-data-delivery>.
- U.S. Geological Survey National Cooperative Geologic Mapping Program, 2020, GeMS (Geologic Map Schema)—A standard format for the digital publication of geologic maps: U.S. Geological Survey Techniques and Methods, book 11, chap. B10, 74 p., <https://doi.org/10.3133/tm11B10>.
- Ver Ploeg, A.J., 1985, Tectonic map of the Bighorn Basin, Wyoming—Oil and gas development posted through July 1985: Geological Survey of Wyoming [Wyoming State Geological Survey] Open File Report 85-11.
- Ver Ploeg, A.J., Boyd, C.S., and Mulbay, J.M., 2004, Geologic map of the Kaycee 30' x 60' quadrangle, Johnson, and Campbell counties, Wyoming: Wyoming State Geological Survey Map Series 63, scale 1:100,000.
- Ver Ploeg, A.J., 2004, Geologic map of the Nowater Creek 30' x 60' quadrangle, northcentral Wyoming: Wyoming State Geological Survey Map Series 39, scale 1:100,000. (Modified from Ver Ploeg, 1992.)
- Ver Ploeg, A.J., and Boyd, C.S., 2002, Geologic map of the Buffalo 30' x 60' quadrangle, Johnson and Campbell counties, Wyoming: Wyoming State Geological Survey Map Series 59, scale 1:100,000.
- Ver Ploeg, A.J., and Boyd, C.S., 2007, Geologic map of the Laramie 30' x 60' quadrangle, Albany and Laramie counties, Wyoming: Wyoming State Geological Survey Map Series 77, scale 1:100,000.
- Wittke, S.J., 2007, Geologic map of the Midwest 30' x 60' quadrangle, Natrona, Converse, Johnson, and Campbell counties, Wyoming: Wyoming State Geological Survey Map Series 73, scale 1:100,000.
- WOGCC, 2022, Wyoming Oil and Gas Conservation Commission, accessed January 2022, at <http://wogcc.wyo.gov/>.

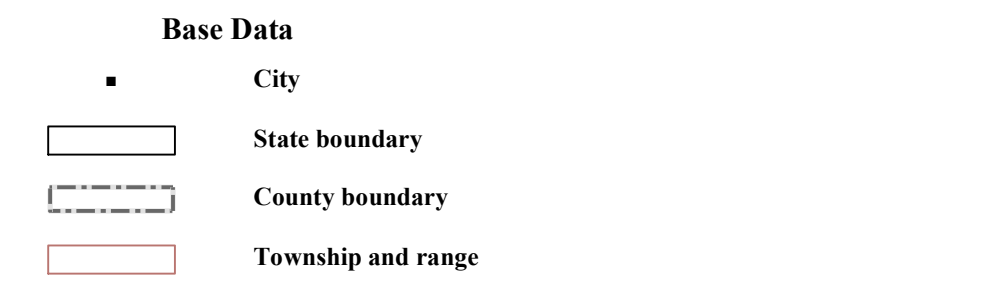
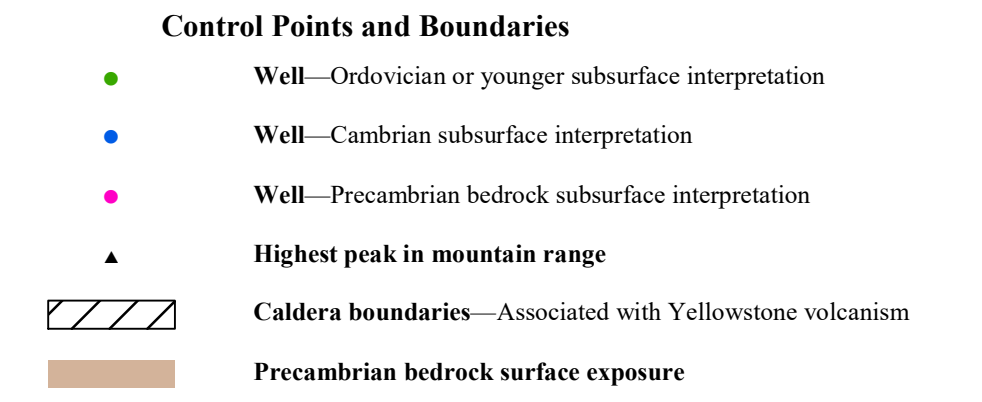
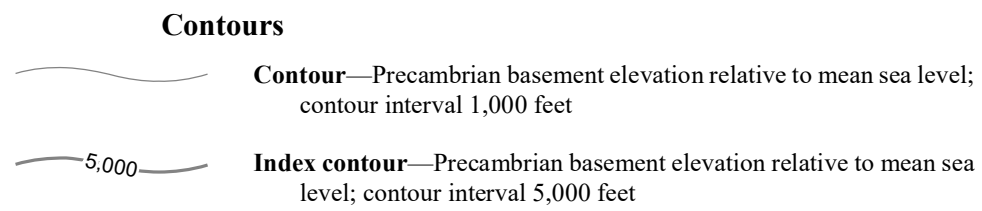
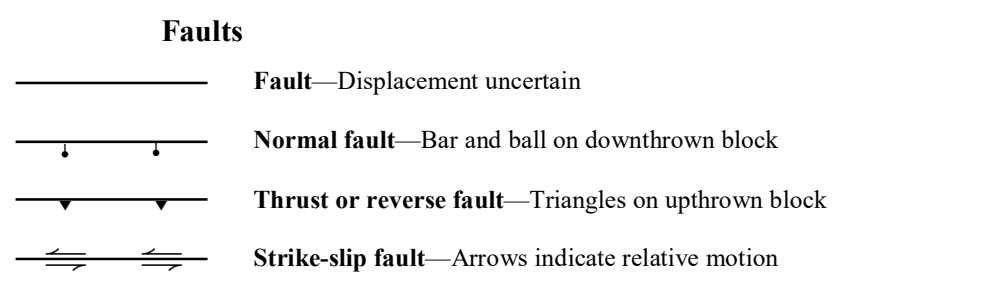
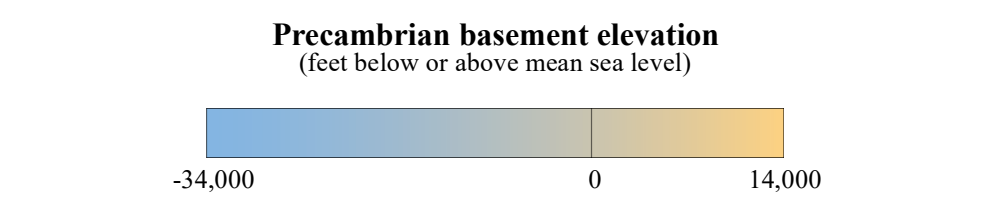


Interpreting the past, providing for the future



EXPLANATION

This map is a general representation of the Precambrian basement in Wyoming. Data used to create the map are interpretations from publicly available sources. While every effort has been made to ensure data and map accuracy, uncertainty in subsurface interpretation is introduced during data acquisition, compilation, and manipulation, and is also present due to variability in scale and geologic interpretation. Spatial information included in this publication is suitable for approximate reference only, and is not to be construed as final, absolute, or used as a substitute for direct local measurements.



REFERENCES

Anderson, G.G., and Askin, E.J., 1983, Structure of the Denver-Julesburg Basin and surrounding areas, in Boland, W.W., and Kretz, P.J., eds., *Geology of the northern Denver Basin and adjacent uplifts*, Rocky Mountain Association of Geologists, 47th field conference, 1983, p. 170-175, 2 pl., scale undetermined.

Bow, R.E., Jr., 1999, Structural interpretation for the southern extent of the Rock Springs uplift, Arlington, University of Texas at Arlington, M.S. thesis, 81 p., 6 pls.

Blackstone, D.L., Jr., 1986, Fractured igneous intrusions in the northern Denver Basin and adjacent areas, Wyoming Geological Survey of Wyoming [Wyoming State Geological Survey Report of Investigation 34, 12 p., scale 1:250,000].

Blackstone, D.L., Jr., 1991, Tectonic relationships of the southeastern Wind River Range, southeastern Wyoming, Utah and northern Idaho, Wyoming Geological Survey of Wyoming [Wyoming State Geological Survey Report of Investigation 47, 24 p., 2 pls., scale 1:250,000].

Blackstone, D.L., Jr., 1993a, Precambrian basement map of Wyoming—Outcrop and structural configuration, Wyoming State Geological Survey Map Series 43, scale 1:100,000.

Blackstone, D.L., Jr., 1993b, Overview of the Hanna, Carbon, and Cooper Lake basins, southeastern Wyoming, Wyoming Geological Survey of Wyoming [Wyoming State Geological Survey Report of Investigation 48, 20 p., 2 pls., scale 1:250,000].

Brenthorn, M.D., and Tabor, R.L., 1985, Deformed and basement-involved structures beneath the Absaroka Range volcanic, in Gries, R.R., and Dyer, R.C., eds., *Scientific exploration of the Rocky Mountain Region: Rocky Mountain Association of Geologists and Denver Geophysical Society*, p. 31-45.

Cook, Lane, 2002, Geologic cross sections of the northern overthrust belt and Hoback Basin, Wyoming, Wyoming State Geological Survey Open File Report 02-5, 15 p., 1 pl.

Flowers, P.T., ed., 1987, *With penetrating basement in South America*, American Association of Petroleum Geologists and U.S. Geological Survey, 707 p., 11 sheets.

Hazel, W.D., 2007, Revised geologic map of South Pass City quadrangle, Fremont County, Wyoming, Wyoming State Geological Survey Map Series 74, scale 1:250,000.

Hess, R.P., and Hickey, B.S., 1985, Geothermal resources of the High Plains Basin, Wyoming [Geological Survey of Wyoming [Wyoming State Geological Survey] Report of Investigation 29, 27 p., 4 pls.].

Hosson, R.S., and Kirtman, S.E., 1992, Geologic map of Precambrian metamorphic rocks of the Medicine Bow Mountains, Albany and Carbon counties, Wyoming, U.S. Geological Survey Miscellaneous Investigations Series Map 1220, 22 p., scale 1:100,000.

Hosson, R.S., McCallum, M.E., King, J.S., Barker, B.B., Myers, W.G., Oriskany, C.J., King, F.R., Chiles, M.P., Ivins, M., Carey, D.L., Gies, J.C., Starnett, D.L., Conroy, J.J., Swenson, M.N., Michael, D.D., and Blackstone, D.L., Jr., 1978, A regional study of Precambrian age in that part of the Medicine Bow Mountains lying in southeastern Wyoming—With a chapter on the relationship between Precambrian and Laramide tectonics, Geological Survey of Wyoming [Wyoming State Geological Survey] Memoir 1, 167 p., 35 pls. (Reprinted from 1983).

Jones, N.B., and Gregory, R.W., 2001, Preliminary geologic map of the Shirley Basin 30' x 60' quadrangle, Carbon, Natrona, Albany, and Converse counties, Wyoming, Wyoming State Geological Survey Open File Report 01-4, scale 1:100,000.

Jones, N.B., Gregory, R.W., and McLaughlin, J.F., 2011, Geologic map of the Bairo 30' x 60' quadrangle, Carbon, Fremont, Sweetwater, and Natrona counties, Wyoming, Wyoming State Geological Survey Map Series 86, scale 1:100,000.

Keefer, W.R., 1976, Structural geology of the Wind River Basin, central Wyoming, U.S. Geological Survey Professional Paper 695-D, 35 p.

Koch, R.D., Ramsey, D.W., and Christiansen, R.L., 2011, Database for the Quaternary and Tertiary Yellowstone Plateau volcanic field of Wyoming, Idaho, and Montana, U.S. Geological Survey Data Series 551 (D-500M) [http://pubs.usgs.gov/ds/551/].

LaFollet, C.B., 1988, Tectonic evolution of Hanna Basin, Wyoming—Lawrence River location in the Rocky Mountain Foreland, Lawrence, University of Wyoming, Ph.D. dissertation, 289 p., 2 pls.

Love, J.D., and Christiansen, A.C., comps., 1983, Geologic map of Wyoming, U.S. Geological Survey, 1 sheet, scale 1:500,000 (Revised 2014, Wyoming State Geological Survey).

Lynde, R.M., 2013, Geologic storage assessment of carbon dioxide (CO₂) in the Laramide Basin of Wyoming, Wyoming State Geological Survey Technical Memorandum No. 1, 20 p.

Mack, J.P., Starnett, J.E., and Witte, S.J., 2002, Geologic of Yellowstone map, Wyoming, Wyoming State Geological Survey, accessed June 2022, at <http://www.wyo.gov/wyoming-geology/geologic-map.asp>.

McLaughlin, J.F., and Ver Ploeg, A.J., 2006, Geologic map of the Newcastle 30' x 60' quadrangle, Weston and Natrona counties, Wyoming, and Pennington and Carter counties, South Dakota, Wyoming State Geological Survey Map Series 71, scale 1:100,000.

Ray, R.R., and Keefer, W.R., 1983, Wind River Basin, central Wyoming, in Gries, R.R., and Dyer, R.C., eds., *Scientific exploration of the Rocky Mountain Region: Rocky Mountain Association of Geologists and Denver Geophysical Society*, p. 201-212.

Sims, P.K., and Day, W.C., comps., 1990, Geologic map of Precambrian rocks of the Hartville uplift, southeastern Wyoming, with a section on mineral deposits in the Hartville uplift, by Terry Klein, U.S. Geological Survey Geologic Investigations Series 2661, 30 p., scale 1:400,000.

Skane, R.C., and Ray, R.R., 1983, Scientific models and interpretation of the Caprot Arch Thrust—Application to Rocky Mountain foreland structure, in Lovell, J.D., and Gries, R.R., eds., *Rocky Mountain foreland basins and uplifts*, Rocky Mountain Association of Geologists, p. 99-124.

Sonnenberg, S.A., 1985, Northwest Denver Basin-southeast Hartville uplift, in Gries, R.R., and Dyer, R.C., eds., *Scientific exploration of the Rocky Mountain Region: Rocky Mountain Association of Geologists and Denver Geophysical Society*, p. 213-231.

Starnett, J.E., Hoffman, C.F., Wicks, S.V., Wilcox, R.M., and Frost, B.R., 2021, Preliminary geologic map of the Rock River 30' x 60' quadrangle, Albany, Carbon, and Laramie counties, Wyoming, Wyoming State Geological Survey Open File Report 2021-5, scale 1:100,000.

Stone, D.S., 1985a, Geologic interpretation of seismic profiles, Big Horn Basin, Wyoming, Part I—East flank, in Gries, R.R., and Dyer, R.C., eds., *Scientific exploration of the Rocky Mountain Region: Rocky Mountain Association of Geologists and Denver Geophysical Society*, p. 165-174.

Stone, D.S., 1985b, Geologic interpretation of seismic profiles, Big Horn Basin, Wyoming, Part II—West flank, in Gries, R.R., and Dyer, R.C., eds., *Scientific exploration of the Rocky Mountain Region: Rocky Mountain Association of Geologists and Denver Geophysical Society*, p. 175-186.

Stone, D.S., 1987, Rocky Mountain thrust—Wyoming, Linton, Colo., DVD, version 2.0, compiled by Stone, D.S., and Halberg, J.L., 2007.

Stone, D.S., 2016, Data reprocessing, multi-scale migration, and formation of vertically segregated Paleocene oil pools at Fortnight field on the Grosventre platform eastern High Plains—Implications for exploration: The Mountain Geologist, v. 4, no. 3, p. 119-138.

Sutherland, W.A., 2007, Geologic map of the Sundance 30' x 60' quadrangle, Crook and Weston counties, Wyoming, and Lawrence and Pennington counties, South Dakota, Wyoming State Geological Survey Map Series 78, 23 p., scale 1:100,000.

Sutherland, W.A., and Hazel, W.D., 2004, Preliminary geologic map of the Santiago 30' x 60' quadrangle, Carbon, and Albany counties, Wyoming, Wyoming State Geological Survey Open File Report 04-10, version 1.1, 30 p., 1 pl., scale 1:100,000.

Tone, R.N., Lynde, R.M., Starnett, J.E., and Lohman, D.L., 2003, Intermediate-scale map of Wyoming, Wyoming State Geological Survey, accessed June 2022, at <http://www.wyo.gov/wyoming-geology/geologic-map.asp>.

Ver Ploeg, A.J., 1985, Tectonic map of the Big Horn Basin, Wyoming—Oil and gas development potential through July 1985, Wyoming Geological Survey of Wyoming [Wyoming State Geological Survey Open File Report 85-11].

Ver Ploeg, A.J., and Boyd, C.S., 2002, Geologic map of the Buffalo 30' x 60' quadrangle, Johnson and Campbell counties, Wyoming, Wyoming State Geological Survey Map Series 65, scale 1:100,000.

Ver Ploeg, A.J., Boyd, C.S., and Mulvey, J.M., 2004, Geologic map of the Kaycee 30' x 60' quadrangle, Johnson and Campbell counties, Wyoming, Wyoming State Geological Survey Map Series 65, scale 1:100,000.

WOGCC, 2022, Wyoming Oil and Gas Conservation Commission, accessed January 2022, at <http://wyo.gov/wyo-gov>.

SUGGESTED CITATION
Wyoming State Geological Survey, 2022, Precambrian basement map of Wyoming—Structural configuration, Wyoming State Geological Survey Open File Report 2022-5, 8 p., 1 pl., scale 1:500,000, <https://doi.org/10.13178/2167187.2022.5>

NOTICE FOR OPEN FILE REPORTS
Open File Reports are preliminary and usually require additional fieldwork and/or consultation and analysis, they are meant to be a first release of information for public comment and review. The Wyoming State Geological Survey welcomes any comments, suggestions, and contributions from users of the information.

NOTICE TO USERS
The Wyoming State Geological Survey (WSGS) encourages the fair use of its material. We request that credit be properly given to the "Wyoming State Geological Survey" when citing information from this publication. Please contact the WSGS at 307-562-2364 or by email at wsgs-info@wyo.gov with questions about citing materials, preparing acknowledgments, extensive use of this material, or to order maps and publications. Individuals with disabilities who require an alternative form of this publication should contact the WSGS. For the TTY relay operator, call 800-877-0975. We appreciate your cooperation.

DISCLAIMER
Users of this map are cautioned against using the data at a scale different from those at which the map was compiled. Using these data at a larger scale will not provide greater accuracy and is a misuse of the data. The Wyoming State Geological Survey (WSGS) and State of Wyoming make no representation or warranty, expressed or implied, regarding the use, accuracy, or completeness of the data presented herein, or of any product derived from these data. The act of distribution shall not constitute such a warranty. The WSGS does not guarantee the data or any map printed or otherwise derived from this publication. The WSGS and State of Wyoming disclaim any responsibility or liability for interpretation made or otherwise derived from this publication, or for any use of this publication for purposes of descriptive or inferential purposes only, or in connection with licensing agreements between the WSGS and users of Wyoming data or products, or for any use of this publication, and does not imply endorsement of those products by the WSGS or State of Wyoming.

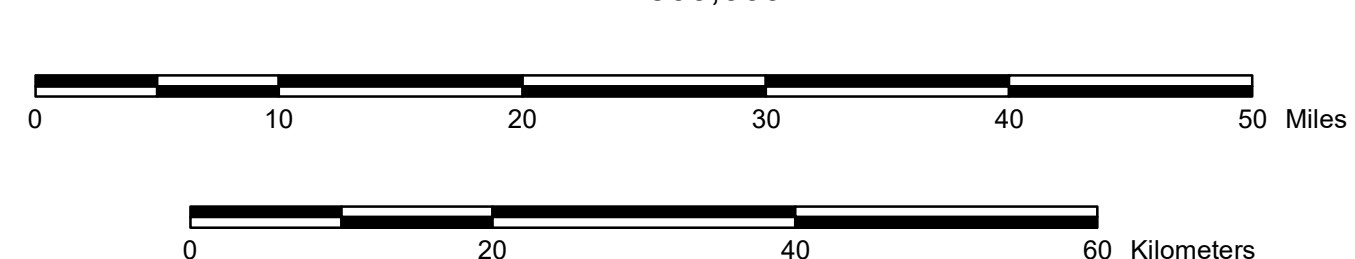
Map Projection: Wyoming Lambert Conformal Conic
Data Source: Wyoming State Geological Survey, 2022
Standard Parallel: 14° 40' North
Standard Parallel: 24° 40' North
Latitude of Origin: 40° North
Geographic North Pole: Arctic Circle (66° 33' North)
Data obtained from: USGS/USGS, National Cartographic and Geospatial Center
30-minute Digital Elevation Model (DEM) Mosaic, 2011, contour 317', unit: single 47', vertical exaggeration 1.2

UTM grid and 2022 magnetic north declination at center of map, from www.ngs.noaa.gov (magnetic is approximate)

PRECAMBRIAN BASEMENT MAP OF WYOMING: STRUCTURAL CONFIGURATION

Wyoming State Geological Survey

Scale 1:500,000



DISCLAIMER

Users of this map are cautioned against using the data at a scale different from those at which the map was compiled. Using these data at a larger scale will not provide greater accuracy and is a misuse of the data. The Wyoming State Geological Survey (WSGS) and State of Wyoming make no representation or warranty, expressed or implied, regarding the use, accuracy, or completeness of the data presented herein, or of any product derived from these data. The act of distribution shall not constitute such a warranty. The WSGS does not guarantee the data or any map printed or otherwise derived from this publication. The WSGS and State of Wyoming disclaim any responsibility or liability for interpretation made or otherwise derived from this publication, or for any use of this publication for purposes of descriptive or inferential purposes only, or in connection with licensing agreements between the WSGS and users of Wyoming data or products, or for any use of this publication, and does not imply endorsement of those products by the WSGS or State of Wyoming.