U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science Directorate
Geologic Resources Division

Jewel Cave National Monument

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic-GIS Data for Jewel Cave National Monument

jeca_geology.pdf

Version: 3/3/2020

Geologic Resources Inventory Map Document for Jewel Cave National Monument

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Geologic Resources Inventory Map Document

Jewel Cave National Monument, South Dakota

Document to Accompany Digital Geologic-GIS Data

jeca_geology.pdf

Version: 3/3/2020

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Jewel Cave National Monument, South Dakota (JECA).

Attempts have been made to reproduce all aspects of the original source products, including the geologic units and their descriptions, geologic cross sections, the geologic report, references and all other pertinent images and information contained in the original publication.

This document contains the following information:

1) **About the NPS Geologic Resources Inventory Program** – A brief summary of the Geologic Resources Inventory (GRI) Program and its products. Included are web links to the GRI GIS data model, and to the GRI products page where digital geologic-GIS datasets, scoping reports and geology reports are available for download. In addition, web links to the NPS Data Store and GRI program home page, as well as contact information for the GRI coordinator, are also present.

2) **GRI Digital Maps and Source Citations** – A listing of the GRI digital geologic-GIS maps produced for this project along with source maps used in their completion. In addition, a brief explanation of how each source map was used is provided. An index map showing Jewel Cave National Monument, and the GRI map extents is also provided. A brief discussion of the newer and older (legacy) GRI maps, and how these maps relate to the 2009 GRI report is also presented.

3) **Digital Geologic-GIS Map of Jewel Cave National Monument**

  a.) **Map Unit List** – A listing of all geologic map units present on this map, listed from youngest to oldest.

  b.) **Map Unit Descriptions** – Descriptions for all geologic map units.

  c.) **Geologic Cross Sections** – Geologic cross section graphic with source geologic cross section abbreviation.

  d.) **Ancillary Source Map Information** – Additional source map information present on the source map.

4) **Digital Geologic-GIS Map of the Jewel Cave National Monument Area**

a.) **Map Unit List** – A listing of all geologic map units present on this map, listed from youngest to oldest.

b.) **Map Unit Descriptions** – Descriptions for all geologic map units.

5) **GRI Digital Data Credits** – GRI digital geologic-GIS data and ancillary map information document production credits.

For information about using GRI digital geologic-GIS data contact:

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About the NPS Geologic Resources Inventory Program

Background

Recognizing the interrelationships between the physical (geology, air, and water) and biological (plants and animals) components of the earth is vital to understanding, managing, and protecting natural resources. The Geologic Resources Inventory (GRI) helps make this connection by providing information on the role of geology and geologic resource management in parks.

Geologic resources for management consideration include both the processes that act upon the Earth and the features formed as a result of these processes. Geologic processes include: erosion and sedimentation; seismic, volcanic, and geothermal activity; glaciation, rockfalls, landslides, and shoreline change. Geologic features include mountains, canyons, natural arches and bridges, minerals, rocks, fossils, cave and karst systems, beaches, dunes, glaciers, volcanoes, and faults.

The Geologic Resources Inventory aims to raise awareness of geology and the role it plays in the environment, and to provide natural resource managers and staff, park planners, interpreters, researchers, and other NPS personnel with information that can help them make informed management decisions.

The GRI team, working closely with the Colorado State University (CSU) Department of Geosciences and a variety of other partners, provides more than 270 parks with a geologic scoping meeting, digital geologic-GIS map data, and a park-specific geologic report.

Products

Scoping Meetings: These park-specific meetings bring together local geologic experts and park staff to inventory and review available geologic data and discuss geologic resource management issues. A summary document is prepared for each meeting that identifies a plan to provide digital map data for the park.

Digital Geologic Maps: Digital geologic maps reproduce all aspects of traditional paper maps, including notes, legend, and cross sections. Bedrock, surficial, and special purpose maps such as coastal or geologic hazard maps may be used by the GRI to create digital Geographic Information Systems (GIS) data and meet park needs. These digital GIS data allow geologic information to be easily viewed and analyzed in conjunction with a wide range of other resource management information data.

For detailed information regarding GIS parameters such as data attribute field definitions, attribute field codes, value definitions, and rules that govern relationships found in the data, refer to the NPS Geology-GIS Data Model document available at: https://www.nps.gov/articles/gri-geodatabase-model.htm

Geologic Reports: GRI reports synthesize discussions from the original scoping meeting, follow up conference call(s), and subsequent research. Chapters of each report discuss the geologic setting of the park, distinctive geologic features and processes within the park, highlight geologic issues facing resource managers, and describe the geologic history leading to the present-day landscape. Each report also includes a poster illustrating these GRI digital geologic-GIS data.

For a complete listing of GRI products visit the GRI publications webpage: https://go.nps.gov/gripubs. GRI digital geologic-GIS data is also available online at the NPS Data Store: https://irma.nps.gov/DataStore/Search/Quick. To find GRI data for a specific park or parks select the appropriate park(s), enter "GRI" as a Search Text term, and then select the Search button.

For more information about the Geologic Resources Inventory Program visit the GRI webpage: https://www.nps.gov/subjects/geology/gri.htm. At the bottom of that webpage is a "Contact Us" link if you need additional information. You may also directly contact the program coordinator:

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The Geologic Resources Inventory (GRI) program is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) Division. Learn more about I&M and the 12 baseline inventories at the I&M webpage: https://www.nps.gov/im/inventories.htm.

GRI Digital Maps and Source Map Citations

The GRI digital geologic-GIS maps for Jewel Cave National Monument, South Dakota (JECA):

Digital Geologic-GIS Map of Jewel Cave National Monument and Vicinity, South Dakota (*GRI MapCode JECA*)

The digital geologic-GIS map was produced using large-scale 1:24,000 source digital data and map image from the following source:

> Fagnan, Brian A., 2009 (revised 2010), Geologic Map of the Jewel Cave Quadrangle, South Dakota: South Dakota Geological Survey, Geologic Quadrangle Map GQ24k-9, scale 1:24,000 (*GRI Source Map ID 75161*).

The GRI used the full extent of the source map, and captured all geologic features within the map extent. In addition, source map elements (e.g., unit colors, unit descriptions, ancillary map graphics and text) were also incorporated into the GRI digital geologic-GIS dataset and product.

In addition to the 1:24,000 scale map, there is a smaller-scale 1:100,000 scale map of the greater area of interest to the monument (the Jewel Cave and Jewel Cave NW 7.'5 quadrangles).

Digital Geologic-GIS Map of the Jewel Cave National Monument Area, South Dakota (*GRI MapCode JWCA*)

The digital geologic-GIS map was produced using small-scale 1:100,000 mylar scans from the following source:

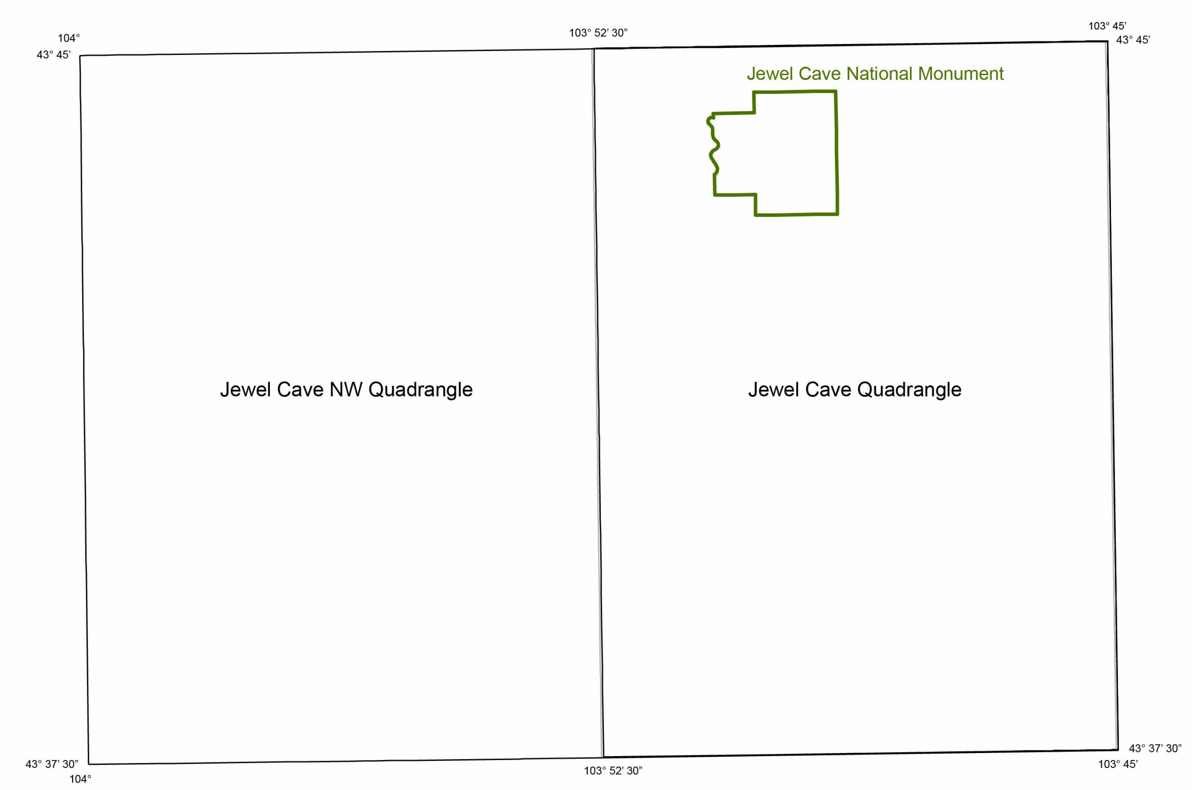
> DeWitt, Ed, 2003, Unpublished Black Hills Geology Mylars: U.S. Geological Survey, unpublished mylars, scale 1:100,000 (*GRI Source Map ID 4145*).

The GRI used a partial extent of the source map, however, all geologic features within the map extent were captured. In addition, brief unit descriptions of units present in the map extent were also incorporated into the GRI digital geologic-GIS product.

Users of GRI digital geologic-GIS data for Jewel Cave National Monument (JECA) are strongly encouraged to now use the newer (2020) Digital Geologic-GIS Map of Jewel Cave National Monument (*GRI MapCode JECA*) as this new map replaces the older map (initially produced in 2004, updated in data format in 2012 and now in 2020 as the "Digital Geologic-GIS Map of the Jewel Cave National Monument Area" or *GRI MapCode JWCA*). The newer map is produced from larger-scale 1:24,000 scale and more detailed mapping. Additional information pertaining to each source map is also presented in the GRI Source Map Information (JECAMAP) table included with the GRI geologic-GIS data.

Index Map

The following index map displays the extent of GRI digital geologic-GIS maps produced for Jewel Cave National Monument (JECA). The extent of the GRI Digital Geologic-GIS Map of Jewel Cave National Monument (*GRI Map Code JECA*) is defined by the extent of the Jewel Cave Quadrangle, whereas the extent of the GRI Digital Geologic-GIS Map of the Jewel Cave National Monument Area (*GRI Map Code JWCA*) is defined by both 7.5 quadrangles shown. The boundary for Jewel Cave National Monument (as of January, 2020) is outlined in green. Of note, the extent of the source digital data and map for the JECA map was off/shifted approximately 38 meters west of the actual east and west extent of the Jewel Cave 7.5' quadrangle. As such, a portion of the mapped extent is actually within the extent of the Jewel Cave NW 7.5' quadrangle, and a portion of the Jewel Cave 7.5' Quadrangle is unmapped. The index map display both extents, with the actual quadrangle extent shown in black, and the "off/shifted" extent of the source map and data shown in gray. This offset is perhaps only visible if the index map is "zoomed into".



Index map produced by Stephanie O'Meara (Colorado State University).

2009 GRI Report and Legacy GRI Dataset

The 2009 GRI report for Jewel Cave National Monument (JECA) was written to the older smaller-scale GRI Digital Geologic-GIS Map of the Jewel Cave National Monument Area (*GRI MapCode JWCA*) map (produced from unpublished 1:100,000 scale U.S. Geological Survey mylar maps by DeWitt, Ed, 2004). Units present on this are presented in the Map Unit Properties section of the 2009 report, however, these units don't directly correspond to the units present on the newer map. In many ways though the units are similar if not exact, and therefore the report's discussion of units is still relevant to the newer more detailed map.

A few noteworthy comments between the old and new maps for Jewel Cave National Monument: 1.) Terrace gravel and alluvial-fan deposits (Qt) on the older (legacy) map were noted as Quaternary in age, and not Tertiary in age as the Gravel deposits (Tg) unit is now recognized to be. 2.) The Spearfish Formation (TRPs), Minnekaha Limestone (Pm) and the Opeche Shale (Po) were only mapped in the Jewel Cave NW 7.5' quadrangle, and thus are not present on the newer map which is as stated for the most part of the Jewel Cave 7.5' quadrangle. 3.) The Minnelusa Formation was mapped as one unit (PPNm) on the older map, however, on the newer map the unit is now mapped as six member units. 4.) Metagabbro (Xgb) is now mapped as amphibolite sills of the Mayo Formation (Xgwda). 5.) Distal metagraywacke (Xgwd) is now likely simply mapped as Mayo Formation, schist (Xgwd).

Digital Geologic-GIS Map of Jewel Cave National Monument

Map Unit List

The geologic units present on the GRI Digital Geologic-GIS Map of Jewel Cave National Monument are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Qal - Alluvium). Units are listed from youngest to oldest. Information about each geologic unit is also presented in the GRI Geologic Unit Information (JECAUNIT) table included with the GRI geologic-GIS data.

Cenozoic Era

Quaternary Period
Qal - Alluvium

Tertiary Period
Tg - Gravel deposit

Paleozoic Era

Permian Period
Pm6 - Minnelusa Formation, unit 6

Permian and Pennsylvanian Periods
PPNm5 - Minnelusa Formation, unit 5

Pennsylvanian Period
PNm4 - Minnelusa Formation, unit 4
PNm3 - Minnelusa Formation, unit 3
PNm2 - Minnelusa Formation, unit 2
PNm1 - Minnelusa Formation, unit 1

Mississippian Period
Mp - Pahasapa Limestone

Mississippian and Devonian Periods
MDe - Englewood Limestone

Ordovician and Cambrian Periods
OCd - Deadwood Formation

Protoerozic Eon? or younger
qv - Quartz vein

Protoerozic Eon
Xgwd - Mayo Formation, schist
Xgwda - Mayo Formation, amphibolite sills
Xu - Undifferentiated Precambrian Rocks

Map Unit Descriptions

Descriptions of all geologic map units, generally listed from youngest to oldest, are presented below. All unit descriptions were taken from the source map: Jewel Cave Quadrangle.

Qal - Alluvium (Quaternary)

Unconsolidated to loosely consolidated clay, silt, and angular to rounded, sand and gravel.

Tg - Gravel deposit (Tertiary)

Unconsolidated to loosely consolidated clay- to boulder-sized clasts comprised of Precambrian quartzite and Paleozoic carbonate and sandstone.

Minnelusa Formation

Pm6 - Minnelusa Formation, unit 6 (Lower Permian)

Minnelusa Formation (unit 6) - Tan, gray, yellow, to red brecciated sandstone interbedded with thin beds of mostly brecciated limestone, andanhydrite, and thin beds of unbrecciated sandstone. Limestone contains fossil brachiopods. Top of unit not exposed in map area.

PPNm5 - Minnelusa Formation, unit 5 (Lower Permian and Upper Pennsylvanian)

Minnelusa Formation (unit 5) - Bright-red, yellow, light-tan, to gray, fine- to coarse-grained sandstone with light-blue-gray chert nodules near base. Interbedded limestone near base weathers similar to upper dolomite of unit 4 of the Minnelusa Formation. Upper portion is a red to light-red breccia with a carbonate matrix. A dark red sandstone separates the lower and upper portions. Approximate thickness is 120 ft (36.6 m).

PNm4 - Minnelusa Formation, unit 4 (Upper Pennsylvanian)

Minnelusa Formation (unit 4) - Brownish-yellow to tan dolomite interbedded with sandstone and laminated limestone. At the base is a bright red to yellow, calcareous, medium- to coarse-grained sandstone, 1-5 ft (0.3-1.5 m) thick. Dolomitic beds commonly contain manganese dendrites. Unit weathers into colluvial slopes. Approximate thickness is 120 ft (36.6 m).

PNm3 - Minnelusa Formation, unit 3 (Upper Pennsylvanian)

Minnelusa Formation (unit 3) - Brownish-yellow to tan, sometimes silicified sandstone interbedded with shale. Unit is poorly exposed, except for silicified outcrop, and weathers into colluvial slopes. Silicified gravel near base. Top of unit contains a brownish-yellow to light-gray, often sandy limestone approximately 30 ft (9.1 m) thick, containing silicified fossils of *Chaetetes milliporaceus* and is used as a distinctive marker bed. This limestone forms sparse outcrops on steep slopes and is often covered by float from unit 4 of the Minnelusa Formation. Approximate thickness is 120 ft (36.6 m).

PNm2 - Minnelusa Formation, unit 2 (Upper Pennsylvanian)

Minnelusa Formation (unit 2) - Yellowish-gray to light-gray, thin bedded limestone. Contains distinctive red and white chert nodules, especially near the top. Limestone beds are up to 2 ft (0.6 m) thick and interbedded with sandstone and shale layers up to 0.5 ft (0.15 m) thick. Forms sparse outcrops. Approximate thickness is 50 ft (15.2 m).

PNm1 - Minnelusa Formation, unit 1 (Upper Pennsylvanian)

Minnelusa Formation (unit 1) - Tan or red, medium- to coarse-grained, cross-bedded, basal sandstone. Overlain by a tan or red, fine-grained, upper siltstone which is compensatory in thickness with the basal sandstone. Unit is poorly exposed and weathers into colluvial slopes. Approximate thickness is 40 ft (12.2 m).

~~~ Disconformity ~~~

Mp - Pahasapa Limestone (Lower Mississippian)

Pahasapa Limestone - Gray to light-tan, cavernous limestone and dolomitic limestone. Fine- to medium-crystalline. Massive bedded limestone in upper portion; thin- to thick-bedded dolomitic sandy limestone in lower portion. Forms prominent cliffs and exposures. Contains rugose corals and spiriferid brachiopods, especially near the upper contact. Approximate thickness 430 ft (131.1 m).

MDe - Englewood Limestone (Lower Mississippian and Upper Devonian)

Englewood Limestone - Lavender, mauve, to pink, interbedded limestone, dolomitic limestone, and purple-gray shale. Laminated to medium bedded. Fine- to medium-crystalline with some coarse-grained crinoidal beds. Bioturbated; contains sparse rugose corals, spiriferid brachiopods, and crinoid stems. Thickness 35-45 ft (10.7-13.7 m).

~~~ Disconformity ~~~

OCd - Deadwood Formation (Lower Ordovician and Middle to Upper Cambrian)

Deadwood Formation - Reddish-brown local basal conglomerate and conglomeratic sandstone, middle glauconitic sandstone, siltstone, and shale, and coarse-grained upper sandstone having nodular weathering. Laminated to thick-bedded. Approximate thickness 160-185 ft (48.8-56.4 m).

~~~ Unconformity ~~~

qv - Quartz vein (Lower Protoerozic Eon? or younger)

No additional description provided on source map.

Xgwd - Mayo Formation, schist (Lower Proterozoic)

Mayo Formation - Xgwd - Quartz-biotite-muscovite schist. Light- to darkgray, medium- to coarse-grained. Thin- to medium bedded, with thickbedded quartzose units. Some beds have fine laminations. Garnets occur locally. Protolith is distal graywacke.

Xgwda - Mayo Formation, amphibolite sills (Lower Proterozoic)

Xgwda - Dark greenish-gray to black sills of amphibolite composed of approximately 50 percent hornblende and 45 percent plagioclase, with 5 percent sphene and magnetite. Sills are medium- to coarse-grained with hornblende phenocrysts to 5 mm in diameter, and have a speckled appearance. Protolith is gabbro intrusions.

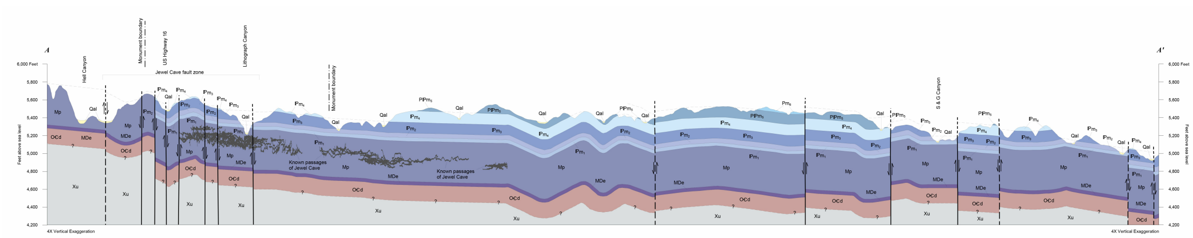
Xu - Undifferentiated Precambrian Rocks (Lower Proterozoic)

Undifferentiated Precambrian rocks - Shown only in cross section.

Geologic Cross Sections

The geologic cross section present in the GRI digital geologic-GIS data produced for Jewel Cave National Monument, South Dakota (JECA) is presented below. The cross section graphic was scanned at a high resolution and can be viewed in more detail by zooming in (if viewing the digital format of this document).

Cross Section A-A'



Graphic from source map: (Jewel Cave Quadrangle). Vertical exaggeration is x4.

Ancillary Source Map Information

The following section presents ancillary source map information associated with the source map used for this project.

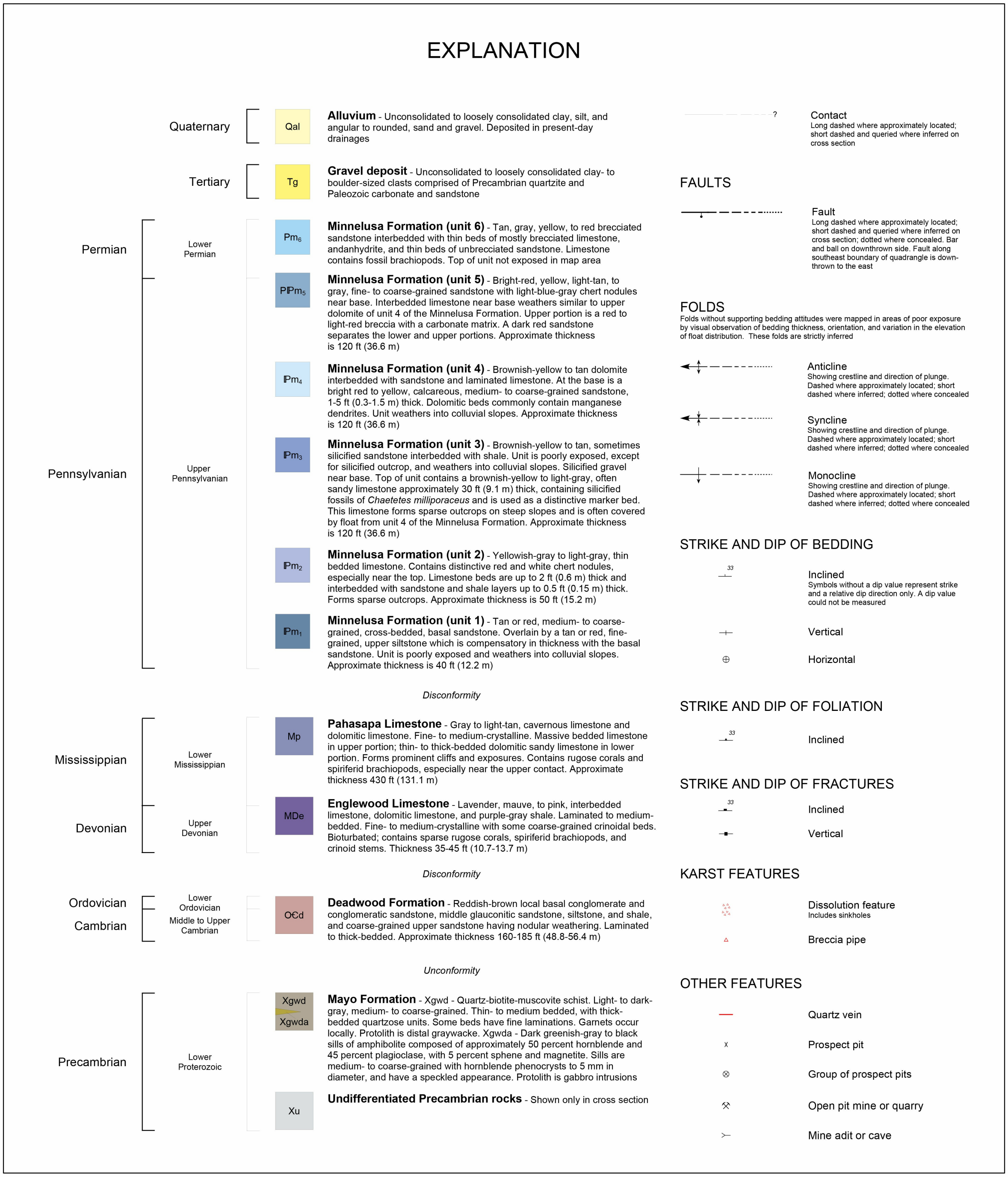
Jewel Cave Quadrangle (SDGS GQ24k-9)

The following source map was used in the completion of the digital geologic-GIS map for Jewel Cave National Monument, South Dakota (JECA):

Fagnan, Brian A., 2009 (revised 2010), Geologic Map of the Jewel Cave Quadrangle, South Dakota: South Dakota Geological Survey, Geologic Quadrangle Map GQ24k-9, scale 1:24,000 (*GRI Source Map ID 75161*).

Prominent graphics and text associated with this source.

Explanation



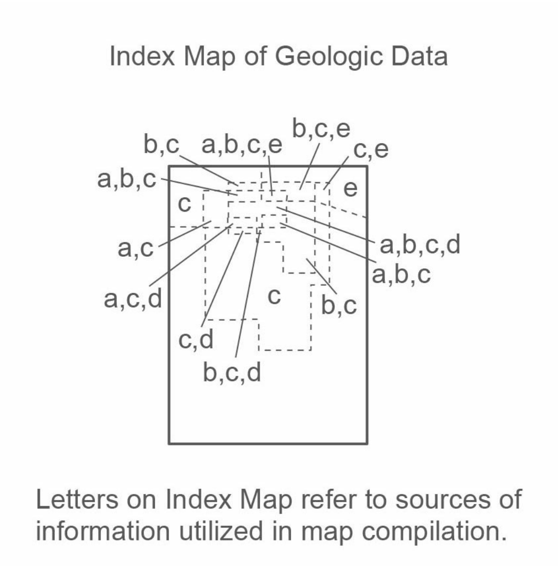
Publication Date: April 16, 2009
Revision Date: February 25, 2010

Graphic from source map: (Jewel Cave Quadrangle)

Location Map

Graphic from source map: (Jewel Cave Quadrangle)

Source of Information Used in Map Compilation



a) Deal, D.E., 1962, Geology of Jewel Cave National Monument, Custer County, South Dakota, with special reference to cavern formation in the Black Hills: Laramie, Wyo., University of Wyoming, M.S. thesis, 183 p.

b) Fagnan, B.A., 2002, Correlation of surface geology with subsurface geology and karst development

at Jewel Cave National Monument, Custer County, South Dakota: Rapid City, S. Dak., South Dakota School of Mines and Technology, M.S. thesis, 143 p.

c) Unpublished National Park Service mapping, circa 1996-2006.

d) Wiles, M.E., 1992, Infiltration at Wind and Jewel Caves, Black Hills, South Dakota: Rapid City, S. Dak., South Dakota School of Mines and Technology, M.S. thesis, 70 p.

e) Yancey, C.L., 1978, Geology and elemental distribution of the Mississippian Pahasapa Limestone-Pennsylvanian Minnelusa Formation unconformity, southwestern Black Hills, South Dakota: Rapid City, S. Dak., South Dakota School of Mines and Technology, M.S. thesis, 72 p.

Graphic and text from source map: (Jewel Cave Quadrangle)

Acknowledgements and Discussion

The geologic mapping performed to produce this map expanded on unpublished National Park Service (circa 1996-2006) work to include the entire Jewel Cave quadrangle. The author thanks the National Park Service for allowing access to all of the unpublished information in their files.

The author received assistance in mapping and interpretation from Mark Fahrenbach (South Dakota Geological Survey), Alvis Lisenbee (South Dakota School of Mines and Technology) and Mike Wiles (Jewel Cave National Monument). Mr. Wiles also served as a map editor, was the primary project contact with the National Park Service and provided the cross section for the map.

Dwight Deal (1962) was the first to produce a map and cross section showing the relationship between the Pahasapa Limestone, the Minnelusa Formation, and the 13 miles of cave passages known at Jewel Cave at the time. Aided by aerial photos, he also mapped lineaments and structures that show remarkably precise correlations with cave passages that had not yet been discovered in 1962. This correlation was the first documented evidence of a relationship between surface and subsurface features.

Mr. Wiles (1992) discovered a strong correlation between sub-units one and two of the Minnelusa Formation and the infiltration of water into Jewel Cave. Nearly all in-cave drip sites are located beneath areas where sub-unit one or two or the Pahasapa Limestone are exposed at land surface. He also observed that the cave passages are located almost exclusively in areas where the Pahasapa Limestone is capped with the Minnelusa Formation. Based on his field work, Mr. Wiles concluded that there is no significant paleo-topographical relief at the top of the Pahasapa Limestone in the Jewel Cave area.

Unpublished geologic mapping by the National Park Service (circa 1996-2006), built on earlier studies by (1) defining six sub-units of the Minnelusa Formation and their stratigraphic relationships, (2) identifying previously unknown structural complexity, (3) documenting extensive dip-slope topography, (4) documenting a significant coincidence between structures and topographic relief (many surface valleys and hills coincide with structural synclines and anticlines, respectively), and (5) revealing that Jewel Cave wraps around what appears to be a plunging syncline trending to the south, located south of the Jewel Cave fault zone. Interpretation of the plunging syncline is based on subsurface information that does not manifest itself in surface exposure, therefore the syncline does not appear as a mapped feature. Another unpublished study by the National Park Service (2006-present), designed to delineate the areal extent of Jewel Cave, has confirmed the relationship between cave passages and the Minnelusa cap; the Pahasapa Limestone hosts large caves only where it is capped with the Minnelusa Formation. In the entire southern Black Hills, caves in the uncapped portions of the Pahasapa Limestone never exceed 200 feet in length.

Text from source map: (Jewel Cave Quadrangle)

Disclaimer

The Geological Survey, Department of Environment and Natural Resources, engages in an ongoing data collection and interpretation process. An outcome of that process is to reflect those interpretations on maps such as this one. Reasonable efforts have been made to ensure that this map accurately reflects the source data used in its preparation. This map is date specific. As additional data become available, geologic interpretations may be revised and the map may be updated by the Geological Survey. This map should not be enlarged or otherwise used in an attempt to interpret more detail than can be seen at the 1:24,000 scale.

Text from source map: (Jewel Cave Quadrangle)

Digital Geologic-GIS Map of the Jewel Cave National Monument Area

Map Unit List

The geologic units present on the GRI Digital Geologic-GIS Map of the Jewel Cave National Monument Area are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Qal - Alluvium). Units are listed from youngest to oldest. Information about each geologic unit is also presented in the Geologic Unit Information (JWCAUNIT) table included with the GRI geologic-GIS data.

Cenozoic Era

Quaternary Period
Qal - Alluvial Deposits
Qt - Terrace gravel and alluvial-fan deposits

Mesozoic Era

Triassic Period
TRPs - Spearfish Formation

Paleozoic Era

Permian Period
Pm - Minnekahta Limestone
Po - Opeche Shale

Pennsylvanian Period
PNm - Minnelusa Formation

Mississippian Period
Mp - Pahasapa Limestone

Mississippian and Devonian Periods
MDe - Englewood Limestone

Ordovician and Cambrian Periods
OCd - Deadwood Formation

Proterozoic Eon
Xgb - Metagabbro
Xgwd - Distal metagraywacke

Map Unit Descriptions

Descriptions of all geologic map units, generally listed from youngest to oldest, are presented below. All unit descriptions were taken from the source map: Unpublished Black Hills geology mylars.

Qal - Alluvial Deposits (Holocene and Pleistocene)

Stream-laid deposits of mud, silt, sand, and gravel. Narrow deposits not shown. Maximum thickness 10 m.

Qt - Terrace gravel and alluvial-fan deposits (Pleistocene)

Gravel, sand, silt soil. Maximum thickness about 30 m. Some higher elevation terrace deposits could be of Pliocene age.

TRPs - Spearfish Formation (Triassic and Upper Permian)

Red shale and siltstone, minor limestone and gypsum. Thickness 70–275 m.

Pm - Minnekahta Limestone (Lower Permian)

Pinkish-gray, thin–bedded limestone. Thickness 10–18 m.

Po - Opeche Shale (Lower Permian)

Maroon shale and siltstone. Thickness 20–40 m.

PPNm - Minnelusa Formation (Lower Permian and Pennsylvanian)

Sandstone, limestone, and minor shale. Thickness 120 to about 350 m.

Mp - Pahasapa Limestone (Lower Mississippian)

Mainly thick-bedded dolomitic limestone. Reef-like bluish limestone in uppermost part. Includes Englewood Limestone (unit MDe) in areas of steep terrane. Thickness 80–210 m.

MDe - Englewood Limestone (Lower Mississippian and Upper Devonian)

Lavender impure limestone. Shown in combination with Pahasapa Limestone (Mp) in areas of steep terrane. Thickness 10–20 m.

OCd - Deadwood Formation (Lower Ordovician and Upper Cambrian)

Glauconitic sandstone, shale, siltstone, and conglomerate. Thickness 0–200 m.

Xgb - Metagabbro (Early Proterozoic)

Dark-green amphibolite, actinolite schist, or greenstone. Small bodies and margins of larger bodies well foliated. Predominantly sill-like bodies. Minor chemical differences in selected samples indicate at least two distinct types of probable different ages.Types are not lithologically distinct and are shown as a single unit where age is uncertain. Thin dikes cutting Xgw2 a few kilometers northwest of Rockerville have rafted inclusions of metabasalt and metachert apparently derived from units Xby and Xqc. Minor bodies not shown.

Of note, units mentioned in the description above are not present in the GRI digital geologic-GIS data, and no additional information pertaining to these units is provided.

Xgwd - Distal metagraywacke (Early Proterozoic)

Grayish-tan schist and siliceous schist including considerable garnet, staurolite, and sillimanite. Calc-silicate lenses developed from former concretions. Restricted to area southwest of Grand Junction fault. Includes Mayo Formation and middle part of Bugtown Formation (Redden, 1963). Correlation of Mayo Formation uncertain due to faulting but may be equivalent to upper graywacke (Xgw3). Thickness of Mayo part of unit about 3,600 m.

Of note, the unit mentioned in the description above (Xgw3) is not present in the GRI digital geologic-GIS data, and no additional information pertaining to this unit is provided.

GRI Digital Data Credits

This document was developed and completed by Stephanie O'Meara (Colorado State University) for the NPS Geologic Resources Division (GRD) Geologic Resources Inventory(GRI) Program. Quality control of this document by James Winter (Colorado State University).

The information in this document was compiled from the GRI source map, and intended to accompany the digital geologic-GIS map and other digital data for Jewel Cave National Monument, South Dakota (JECA) developed by Stephanie O'Meara and Jake Suri (Colorado State University; see the GRI Digital Maps and Source Map Citations section of this document for all sources used by the GRI in the completion of this document and related GRI digital geologic-GIS maps.

GRI finalization by Stephanie O'Meara (Colorado State University).

GRI program coordination and scoping provided by Jason Kenworthy and Tim Connors (NPS GRD, Lakewood, Colorado).