South Dakota Department of Environment & Natural Resources Geological Survey

Department of Environment and Natural Resources
Division of Financial and Technical Assistance
Geological Survey
7.5 Minute Series Geologic Quadrangle Map 9

Geologic Map of the Jewel Cave Quadrangle, South Dakota

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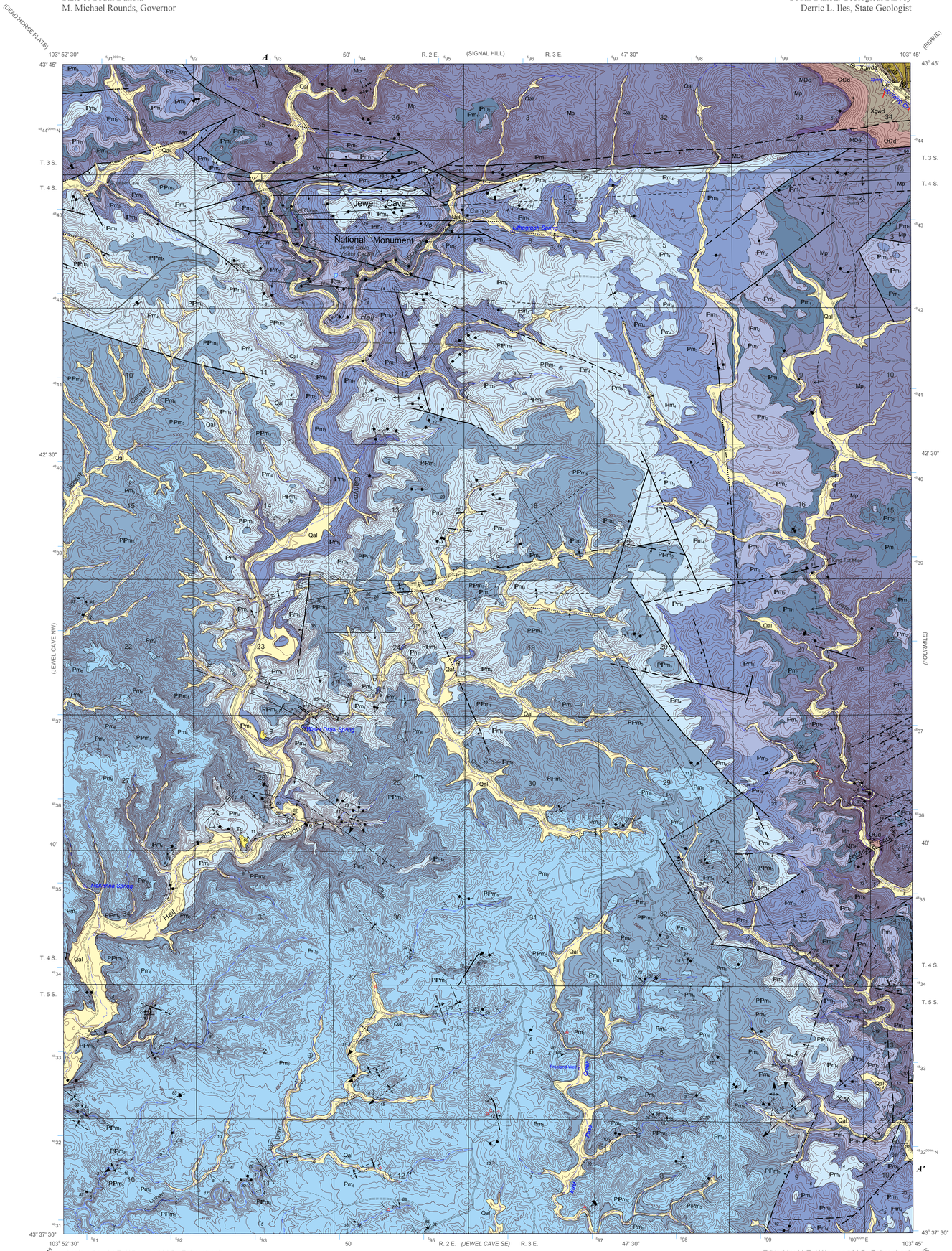
2009

State of South Dakota
M. Michael Rounds, Governor

South Dakota Geological Survey
Derric L. Iles, State Geologist

Prepared in cooperation with the Department of the Interior,
National Park Service, Jewel Cave National Monument



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Map base modified from U.S. Geological Survey 1:24,000-scale Jewel Cave digital line graph.
Projection is Universal Transverse Mercator, Zone 13.
Datum is 1983 North American.
UTM grid information generated from the Arcmap layout grid function.

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.

SCALE 1:24,000

1 0.5 0 1 Mile
1,000 0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 Feet
1 0.5 0 1 Kilometer

CONTOUR INTERVAL 20 FEET

NORTH

1° 31′ 27 MILS
8° 53′ 142 MILS

APRIL 16, 2009, MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

South Dakota

Quadrangle location

EXPLANATION

Quaternary

Qal — **Alluvium** - Unconsolidated to loosely consolidated clay, silt, and angular to rounded, sand and gravel. Deposited in present-day drainages

Tertiary

Tg — **Gravel deposit** - Unconsolidated to loosely consolidated clay- to boulder-sized clasts comprised of Precambrian quartzite and Paleozoic carbonate and sandstone

Permian

Lower Permian

P_{m_6} — **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

Pennsylvanian

Upper Pennsylvanian

PP_{m_5} — **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)

P_{m_4} — **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)

P_{m_3} — **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)

P_{m_2} — **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)

P_{m_1} — **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

Mississippian

Lower Mississippian

Mp — **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)

Devonian

Upper Devonian

MDe — **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

Ordovician Cambrian

Lower Ordovician Middle to Upper Cambrian

OCd — **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

Precambrian

Lower Proterozoic

Xgwd / Xgwda — **Mayo Formation** - Xgwd - Quartz-biotite-muscovite schist. Light- to dark-gray, medium- to coarse-grained. Thin- to medium bedded, with thick-bedded quartzose units. Some beds have fine laminations. Garnets occur locally. Protolith is distal graywacke. 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** - Shown only in cross section

Contact
Long dashed where approximately located; short dashed and queried where inferred on cross section

FAULTS

Fault
Long dashed where approximately located; short dashed and queried where inferred on cross section; dotted where concealed. Bar and ball on downthrown side. Fault along southeast boundary of quadrangle is down-thrown to the east

FOLDS

Folds without supporting bedding attitudes were mapped in areas of poor exposure by visual observation of bedding thickness, orientation, and variation in the elevation of float distribution. These folds are strictly inferred

Anticline
Showing crestline and direction of plunge. Dashed where approximately located; short dashed where inferred; dotted where concealed

Syncline
Showing crestline and direction of plunge. Dashed where approximately located; short dashed where inferred; dotted where concealed

Monocline
Showing crestline and direction of plunge. Dashed where approximately located; short dashed where inferred; dotted where concealed

STRIKE AND DIP OF BEDDING

Inclined
Symbols without a dip value represent strike and a relative dip direction only. A dip value could not be measured

Vertical

Horizontal

STRIKE AND DIP OF FOLIATION

Inclined

STRIKE AND DIP OF FRACTURES

Inclined

Vertical

KARST FEATURES

Dissolution feature
Includes sinkholes

Breccia pipe

OTHER FEATURES

Quartz vein

Prospect pit

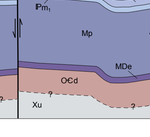
Group of prospect pits

Open pit mine or quarry

Mine adit or cave

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

Index Map of Geologic Data



Letters on Index Map refer to sources of information utilized in map compilation.

Sources of Information Utilized 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.

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.