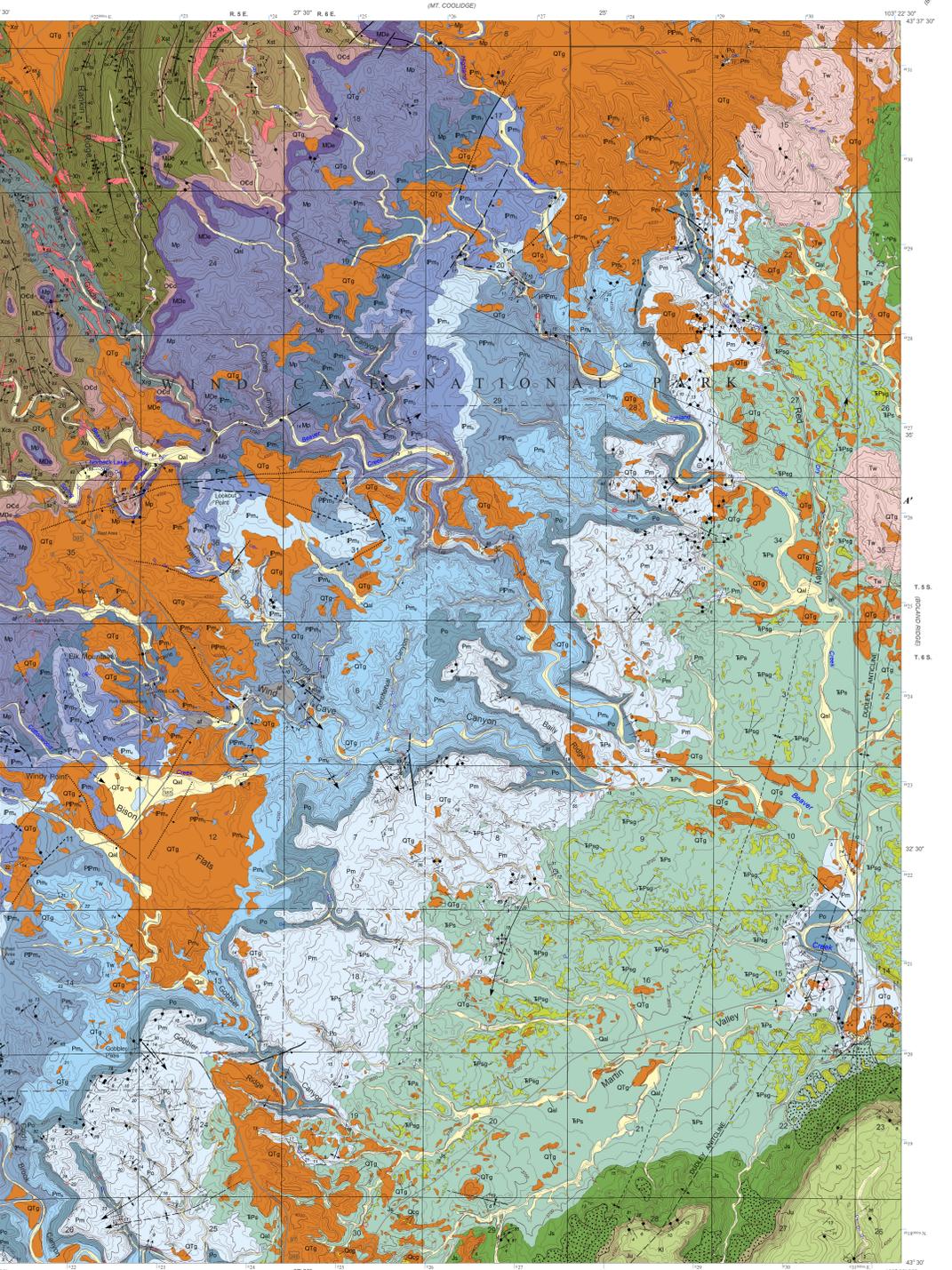


Geologic Map of the Wind Cave Quadrangle, South Dakota

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2011

State of South Dakota
Dennis Daugaard, Governor

South Dakota Geological Survey
Derric L. Iles, State Geologist



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Map base modified from U.S. Geological Survey 1:24,000-scale Wind Cave digital line graph.
Projection is Universal Transverse Mercator, Zone 13N.
Datum is 1983 North American.
UTM grid information generated from the Arcmap layout grid function.
Sec. 3, T. 6 S., R. 6 E. and 1/2 E., Sec. 4, T. 6 S., R. 6 E. were mapped using air photos.

The Geological Survey Program, 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 a scale of 1:24,000.

SCALE 1:24,000

NORTH

South Dakota

Quadrangle location

CONTOUR INTERVAL 20 FEET

APRIL 13, 2011 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

Acknowledgements

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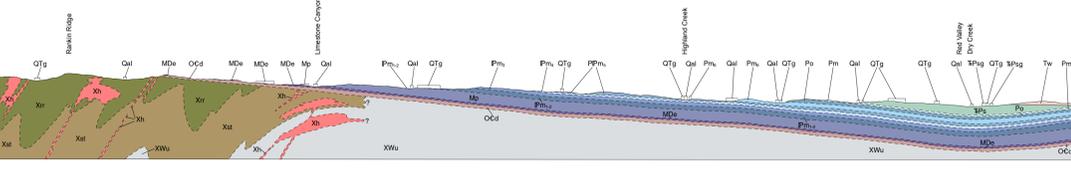
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Prepared in cooperation with Albion College, Albion, Michigan

EXPLANATION

Quaternary	Qal Alluvium - Unconsolidated to loosely consolidated clay, silt, and angular to rounded, sand and gravel. Deposited in present-day channels.	Qcg Conglomerate - Well-cemented, angular to subangular, sand- to pebble-sized clasts comprised of Precambrian lithologies and minor quantities of Precambrian and Early Paleozoic lithologies. Matrix is composed of calcium carbonate and calcium sulfate probably derived from hot springs (Wolcott, 1967). Some conglomerate could be associated with the White River Group but was not differentiated in the study area. Approximate thickness 2-15 ft (0.6-4.6 m)	Qtg Gravel deposit - Unconsolidated to loosely consolidated clay- to boulder-sized clasts comprised of Precambrian lithologies and minor Paleozoic carbonates and sandstone. All gravels are sub-rounded to rounded. Some gravel deposits could be associated with the White River Group but were not differentiated in the study area.	Contact Long dashed where approximately located; short dashed where inferred only in cross section
Tertiary	Disconformity	Tw White River Group - Tan, brown, and light-gray siltstone, claystone, and white to light-gray, vuggy, finely-crystalline, lacustrine limestone. Contains sparse lenses of conglomerate indicating possible stream channels. Some gravel deposits of unit Qtg could be associated with the White River Group but were not differentiated in the study area. Exposed thickness greater than 200 ft (61 m)	Form line TC indicates dip direction of beds	FAULT Fault Long dashed where approximately located; short dashed where inferred; dotted where concealed Fault showing troughline and direction of plunge. Long dashed where approximately located; short dashed where inferred; dotted where concealed
Cretaceous	Disconformity	Kf Fall River Formation - Gray to light-gray, fine- to very fine-grained, thin-bedded, carbonaceous sandstone interbedded with laminated, carbonaceous siltstone. Exposed thickness greater than 100 ft (30.5 m)	Kl Lakota Formation - Tan, brown, and light-gray, medium- to coarse-grained, cross-bedded sandstone interbedded with mudstone. Middle of the formation contains lenses of sandy limestone. Forms prominent outcrops; large boulders may occur as colluvium or talus. Contains perforated wood. Approximate thickness 200-350 ft (61-106.7 m)	FOLDS Anticline Showing crestline and direction of plunge. Long dashed where approximately located; short dashed where inferred; dotted where concealed Syncline Showing troughline and direction of plunge. Long dashed where approximately located; short dashed where inferred; dotted where concealed Monocline, anticlinal bend Axis located on steepest part of structure. Shorter arrow indicates steeper beds. Long dashed where approximately located; dotted where concealed Overturned anticline Location of trace of axial surface and dip direction of folds; long dashed where approximately located; dotted where concealed Overturned syncline Location of trace of axial surface and dip direction of folds; long dashed where approximately located; dotted where concealed
Jurassic	Disconformity	Ju Unkapa Sandstone - Buff to white, calcareous, well-sorted, friable, quartz sandstone. Locally pink to purple in the top of the formation. Fine- to medium-grained, cross-bedded. Approximate thickness 10-50 ft (3.0-15.2 m)	Jc Sundance Formation - Includes the members listed below, which were observed in the field but not shown separately on the map or cross section. Approximate thickness 240-270 ft (73.2-82.3 m)	Small anticline Showing bearing and plunge Small syncline Showing bearing and plunge Minor fold Axis and plunge of single fold Dome Point of observation where symbols join
Middle Jurassic	Disconformity	Lak Lak Shale Member - Red, fine-grained, calcareous, glauconitic siltstone and sandstone. Distinct as a marker bed when seen in outcrop	Hulet Hulet Sandstone Member - Light gray, fine-grained, calcareous, glauconitic sandstone interbedded with gray-green claystone. Contains abundant ripple marks	Strike and Dip of Bedding Inclined Horizontal Overturned Where direction of younging is known
Lower Jurassic	Disconformity	Stockade Stockade Shale Member - Tan to light gray-green, calcareous, glauconitic, thin-bedded shale, sandstone, and siltstone. Contains the fossil <i>Pachydictya</i> sp.	Canyon Springs Canyon Springs Sandstone Member - Tan, gray, and yellow, medium-grained, cross-bedded sandstone. Contains ripple marks	Strike and Dip of Foliation Inclined Strike and Dip of Fractures Inclined Vertical Multiple Point of observation where symbols join
Triassic	Disconformity	Sp Spearfish Formation - Red to maroon shale and siltstone. Interbedded brecciated limestone beds up to 2 ft (0.6 m) thick locally near the base. Discontinuous gypsum beds (SPgs) up to 3 ft (0.9 m) thick are abundant locally near the top, with small veins and lenses throughout the middle to the top of the formation. Dislocation features are indicated by fragments of shale and siltstone sliced in the gypsum. Approximate thickness 350-400 ft (106.7-121.9 m)	Pm Minnekahta Limestone - White, pink, and purple, finely-crystalline, laminated to thin-bedded, locally petrolierous limestone. Interbedded with thin layers of shale at the middle and base. Forms prominent dip slopes and cliffs. Contains minor folds and box faults throughout the formation. Approximate thickness 40-50 ft (12.2-15.2 m)	KARST FEATURE Area of collapse Due to dissolution of underlying beds Breccia pipe or sinkhole Stream loss zone
Upper Permian	Disconformity	Po Opeche Shale - Unconsolidated red to maroon shale, mudstone, and siltstone having varying degrees of weathering. Weathers to a fine soil. Poorly exposed on broad slopes beneath the Minnekahta Limestone. Approximate thickness 80-100 ft (24.4-30.5 m)	Pm1 Minnelusa Formation (unit 6) - Tan, gray, yellow, to red brecciated sandstone interbedded with thin beds of mostly brecciated limestone, discontinuous thin layers of anhydrite, and thin beds of unbrecciated sandstone, all poorly exposed. Limestone contains brachiopods. Top of unit contains bright-red interbedded shale and sandstone. Sandstone beds form prominent bench outcrops. Approximate thickness 110-150 ft (33.5-39.6 m)	OTHER FEATURES Landslide deposit Extrinsic landside deposits derived from the Lakota Formation Artificial fill Compacted earth, indicated only where extensive Mine adit or cave Prospect pit Gravel pit Open pit mine Quarry
Permian	Disconformity	Pm2 Minnelusa Formation (unit 5) - Bright-red, yellow, light-tan, to gray, fine- to coarse-grained sandstone with light-blue-gray chert nodules near base. Upper portion is a red to light-red breccia with a carbonaceous matrix. A dark-red sandstone separates the lower and upper portions. Approximate thickness 80-100 ft (24.4-30.5 m)	Pm3 Minnelusa Formation (unit 4) - Brownish-yellow to tan dolomite interbedded with sandstone and laminated limestone. Dolomite beds may contain manganese dendrites. Unit weathers into colluvial slopes. Approximate thickness 60-80 ft (18.3-24.4 m)	
Upper Pennsylvanian	Disconformity	Pm4 Minnelusa Formation (unit 3) - Brownish-yellow to tan, sometimes silicified sandstone interbedded with shale. Unit is poorly exposed, except for silicified sandstone interbedded with shale, and weathers into colluvial slopes. Top of unit may contain a brownish-yellow to light-gray, sandy limestone. Approximate thickness 100-120 ft (30.5-36.6 m)	Pm5 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 0.2 ft (0.2 m) thick. Unit is poorly exposed. Approximate thickness is 40-60 ft (12.2-18.3 m)	
Lower Pennsylvanian	Disconformity	Pm6 Minnelusa Formation (unit 1) - Tan or red, medium- to coarse-grained, cross-bedded, basal sandstone. Overlain by 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 25-90 ft (7.6-27.4 m)	Mp Pahasapa Limestone - Gray to light-tan, cavernous limestone and dolomitic limestone. Massive limestone with sparse chert nodules in the upper portion; thin- to medium-bedded, dolomitic, sandy limestone in the lower portion. Forms prominent cliffs. Disconformity between the Pahasapa Limestone and the overlying Minnelusa Formation (unit 1) is a paleokarst surface containing terra rossa filled sinkholes and breccia pipes. Contains abundant tabulate corals, spiriferid brachiopods, and burlows, and sparse gastropods and rugose corals. Approximate thickness 275-375 ft (83.8-114.3 m)	
Mississippian	Disconformity	Mdb 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 crystalline beds. Burled; contains sparse rugose corals, spiriferid brachiopods, and crinoid columns. Thickness 35-50 ft (10.7-15.2 m)	Ocd Deadwood Formation - Reddish-brown, basal conglomeratic sandstone and local conglomerate; middle glauconitic sandstone, siltstone, and shale; upper coarse-grained sandstone having nodular weathering. Laminated to thick-bedded. Contains trilete and mariculate brachiopod fragments. Approximate thickness 65-75 ft (19.8-22.9 m)	
Upper Devonian	Disconformity	Xh Harney Peak Granite - Sills and dikes of predominantly coarse-grained to pegmatitic, tan to pink S-type granite. Age 1.715 Ma ± 3 Ma (Redden et al., 1990)	Xq Unnamed formation Xq (Redden and DeWitt, 2008) Possibly equivalent to Buck Mountain Quartzite of Bayley (1972). Here subdivided into the following units: Xcs Cold Spring Creek quartzite unit - Interbedded quartzite and micaceous schist. Some quartzite layers near base are bottle-bearing; upper quartzite layers are typically pure. Includes sections of thick-bedded quartzite without intervening schist, resulting in cliff- and ridge-forming quartzite intervals up to 40 ft (12.2 m) thick. Interbedded schists include laminated biotite-muscovite schist, biotite-muscovite schist, and quartz-biotite-muscovite-garnet schist Xrg Reeves Gulch schist unit - Biotite schist and thick- to thin-bedded impure quartzite and biotite-quartzite interbedded with thin-bedded to laminated quartz-biotite schist, quartz-biotite-plagioclase schist, and quartz-biotite-muscovite schist. Also contains minor thick quartzite beds, intervals of uniform, biotite-muscovite-rich schist, and minor garnet-rich layers which contain up to 3 percent manganese Xri Rankin Ridge quartzite unit - Quartzite and siliceous schist. Thick-bedded, clean quartzite and minor biotite quartzite interbedded with poorly exposed fine-grained quartzite with muscovite partings, fine-grained quartz-muscovite schist, fine-grained quartz-biotite schist, and thin coarse-grained quartz-biotite-sillimanite schist. Includes thick-bedded quartzite without intervening schist, forming cliffs and ridges of quartzite intervals up to 70 ft (21.3 m) thick. Some quartzite beds are graded allowing determination of tops Xst Sanctuary Trail schist unit - Schist, quartz-plagioclase rock, and quartzite. Coarse-grained quartz-biotite-muscovite-sillimanite-muscovite schist containing less than 50 percent quartz is abundant in lower section but occurs throughout the unit. Characteristic thin-bedded, quartz-rich, quartz-plagioclase-biotite-muscovite with or without micaceous rocks are abundant in the upper part of the unit. Biotite- and feldspar-bearing quartzite and pure quartzite occur throughout, becoming more abundant near the top XWu Undifferentiated Lower Proterozoic and Upper Archean rocks - Shown only in cross section	
Lower Devonian	Disconformity			
Lower Ordovician	Disconformity			
Middle to Upper Cambrian	Disconformity			
Precambrian	Disconformity			