Map Unit Properties Table for Wind Cave National Park

Age	Map Unit (Symbol)	Description	Mineral Resources	Paleontological Resources	Suitability for Development/Recreation
QUATERNARY (Holocene and Pleistocene)	Alluvial deposits (Qal)	Mud, silt, sand, and gravel; fluvial deposits; maximum thickness 10 m (33 ft)	Gravel deposits	None documented	Local aquifer where saturated; active gullying in Highland Creek drainage
	Landslide deposits (Ql)	Small colluvial deposits typically along escarpments of Pierre Shale	None documented	None documented	Unsuitable
	Colluvium or talus (Qc)	Angular blocks and debris masking bedrock; maximum thickness 10 m (33 ft)	None documented	None documented	Generally not an aquifer, even when saturated
	Terrace gravel and alluvial-fan deposits (Qt)	Gravel, sand, and silt; some higher elevation terrace deposits could be of Pliocene age; four alluvial terrace levels and numerous alluvial fans in Highland Creek drainage; maximum thickness 30 m (100 ft)	Well-rounded gravel in Highland Creek drainage	*Bison* vertebra and charcoal (Ponderosa pine) in Highland Creek drainage	Potential for landslides on north- and east-facing scarps
TERTIARY	White River Group (Tw)	Silty claystone and poorly indurated sandstone, arkose, and conglomerate; gravel at higher elevations; divided into Brule (top) and Chadron (base) formations; maximum thickness 120 m (390 ft)	Gravel deposits, skarns	Bones of rhinoceros and early horse; remains of tortoise, deerlike mammal, and unidentified carnivore	Minor aquifer where saturated
CRETACEOUS	Pierre Shale (Kp)	Dark-gray to black shale; maximum thickness 500 m (1,640 ft)	Concretions	Teepee buttes underlain by fossiliferous limestone formed by methane-rich spring deposits	Bentonite beds
	Niobrara Formation (Kn)	Gray to yellowish-tan, thin-bedded limestone and calcareous shale; thickness 60–100 m (200–330 ft)	None documented	None documented	
	Carlile Shale (Kc)	Gray shale and a few tan siltstone and resistant sandstone beds; thickness 100–200 m (330–660 ft)	None documented	None documented	
	Greenhorn Limestone (Kg)	Light-gray to tan, thin-bedded limestone and calcareous shale; thickness 70–120 m (230–390 ft)	None documented	None documented	
	Belle Fourche Shale (Kb)	Gray to black shale; thickness 70–200 m (230–660 ft)	Concretions	None documented	
	Mowry Shale (Km)	Dark-gray shale, locally somewhat siliceous; thickness 40–70 m (130–230 ft)	Lead and manganese	Fish scales	
	Skull Creek Shale (Ks)	Dark-gray to black shale; underlies minor valleys where Newcastle Sandstone is present; thickness 55–80 m (180–260 ft)	Iron-stained concretions	None documented	None documented
	Fall River Formation (Kf)	Sandstone interbedded with gray to dark-gray shale near top; thickness 35–70 m (115–230 ft)	Uranium	None documented	Landslides on north- and east-facing scarp of hogback; major regional aquifer
	Lakota Formation (Kl)	Sandstone, mudstone, and shale; upper part is hard siltstone; thickness 85–150 m (280–490 ft)	Uranium	Petrified wood	Major regional aquifer
JURASSIC	Morrison Formation and Unkpapa Sandstone, undivided (Jmu)	Morrison Formation: Shale and sandstone; minor limestone; maximum thickness 50 m (160 ft) Unkpapa Sandstone: Fine-grained eolian (windblown) sandstone; lenses out to the west; thickness as much as 85 m (280 ft).	None documented	Morrison Formation: Known worldwide for skeletons of large dinosaurs, especially giant sauropods; significant for reconstructing Late Jurassic, predominately terrestrial ecosystem throughout the Western Interior	Very small slumps (Ql) in Jurassic rocks
	Sundance and Gypsum Spring formations, undivided (Jsg).	Sundance Formation: Interbedded shale, siltstone, and sandstone; thickness 70–160 m (230–525 ft) Gypsum Spring Formation: Gypsum and shale; maximum thickness 25 m (80 ft)	Gypsum	None documented	Very small slumps; readily eroded Sundance Formation: Locally productive aquifer where saturated
TRIASSIC	Spearfish Formation (ŦRPs)	Red shale and siltstone, minor limestone and gypsum; collapse structures (limestone-dolomite breccias) produced by the solution of anhydrite in early Cenozoic; thickness 70–275 m (230–900 ft)	Gypsum	None documented	Minor deformational structures (e.g., small thrust faults, minor folds, dolomite breccia, and pull-apart structures [in gypsum]); readily eroded
PERMIAN	Minnekahta Limestone (Pm)	Pinkish-gray, thin-bedded limestone; thickness 10–18 m (33–60 ft)	Calcite and anhydrite crystals; source for crushed rock, ballast, riprap, and building stone; used for cement and lime	Pelecypod shells, gastropod casts, fragmentary fish remains, possible algal structures	Minor deformational structures (e.g., small thrust faults, minor folds, dolomite breccia, and pull-apart structures [in gypsum]); subsidence structures from dissolution of anhydrite; aquifer
	Opeche Shale (Po)	Maroon shale and siltstone; thickness 20–40 m (66–130 ft)	None documented	None documented	Unknown

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PENNSYLVANIAN	Minnelusa Formation (Ꝑhm)	Red, thin-bedded sandstone, limestone, and minor shale; fills paleokarst features in upper Pahasapa Limestone; collapse structures (breccias) produced by the solution of anhydrite in early Cenozoic under humid conditions; persistent layer of red mudstone marks Pennsylvanian-Permian boundary; correlative to Amsden Formation in Wyoming; forms irregular slopes and low ledges at surface; thickness 120–200 m (395–660 ft)	Sand used for glass manufacturing; accessory minerals in sandstone: zircon, tourmaline, leucoxene, carbonate, pyrite with anhydrite, and fluorite	Foraminifera confirm Permian age of upper red mudstone layer, conodonts	Sandstone intervals are good aquifers; too thinly bedded for cave development; extensive faults and folds (reflect structure of underlying Pahasapa Limestone); areas of solution and collapse regionally
MISSISSIPPIAN	Pahasapa Limestone (Mp)	Thickest limestone layer in Black Hills; mainly thick-bedded dolomitic limestone; reeflike bluish limestone in uppermost part; correlative with Madison Limestone of Wyoming and Montana, Leadville Limestone of Colorado, and Redwall Limestone of Arizona; thickness 80–210 m (260–690 ft) Upper unit: Massive limestone characterized by pre-Pennsylvanian caves and solution pockets; smooth arched ceilings and walls in cave, very little boxwork; prominent cliffs at surface Middle unit: Chert beds separate upper and middle unit; pre-Pennsylvanian solution pockets and fossils near top; predominantly bedded limestone and dolomite; low, wide rooms and passages in upper beds in cave, much boxwork; irregular fissures in lower beds; slopes with low ledges at surface Lower unit: Massive, limy dolomite; boxwork, prominent fissure passages, wall coatings of calcite crystals in cave; prominent cliffs at surface	Chert beds; calcite spar lining in cave and many smaller cavities lined with calcite; mined for limestone and dolomite; gold and silver in dolomitic zones	Fossil shells (brachiopods and gastropods), colonial corals, burrows	Contains nearly all Black Hills caves; forms steep-walled cliffs in canyons; regional aquifer; feebly thermal/highly mineralized hot springs
MISSISSIPPIAN DEVONIAN	Englewood Limestone (MDe)	Impure lavender limestone; thickness about 9 m (30 ft)	None documented	Uppermost 2.4 m (8 ft) highly fossiliferous	Unknown
ORDOVICIAN CAMBRIAN	Deadwood Formation (O€d)	Glauconitic sandstone, shale, siltstone, and conglomerate; thickness about 9 m (30 ft)	Silica	None documented	Aquifer; extensive minor faults and folds
PRECAMBRIAN	Harney Peak Granite (Xh)	Layered granite, pegmatitic granite, and pegmatite; consists of hundreds of intrusions, more than 24,000 separate bodies of pegmatite and granite	Pegmatite contains tourmaline, biotite, feldspar, and beryl	None documented	Numerous faults of diverse types and ages cut Precambrian rocks in the Black Hills
	Metagabbro (Xgb)	Predominantly sill-like bodies of dark-green amphibolite, actinolite schist, or greenstone; though not lithologically distinct, minor chemical differences in selected samples indicate at least two distinct ages; highly variable thicknesses up to 305 m (1,000 ft)	None		
	Distal metagraywacke (Xgwd)	Grayish-tan and siliceous schist; calc-silicate lenses developed from former concretions; exceeds 3,600 m (11,810 ft) in thickness	Garnet, staurolite, and sillimanite		
	Proximal metagraywacke (Xgwp)	Light-tan, thick-bedded quartzose schist; total thickness about 2,200 m (7,220 ft)	None		
	Metagraywacke unit 2 (Xgw2)	Middle part of Xgw (greenish-gray to grayish-tan siliceous schist); lithologically similar to Xgw3 (gray to tan siliceous schist); may be as much as 2,000 m (6,560 ft) thick	None		
	Metamorphosed younger alkalic basalt, tuff, and volcaniclastic rocks (Xby)	Pillowed chloritic greenstone or amphibolite, and layered amphibole schist and amphibole-bearing or biotite-rich schist; intertongues with tuffaceous shale, tuff, and volcaniclastic rocks (unit Xtv) that have U-Pb zircon age of 1,884±29 million years; maximum thickness 1,000 m (3,280 ft)	Sulfide minerals or graphite		
	Metamorphosed quartzite, debris-flow conglomerate, pelite, and graywacke (Xqc)	Heterogeneous, gray to tan quartzite, metaconglomerate, and phyllite or schist; thickness 30–700 m (100–2,300 ft)	Garnet, staurolite, andalusite, and sillimanite		
	Metamorphosed quartzite and pelite (Xqs)	Interbedded quartzite, grayish-tan schist, and phyllite; maximum thickness 1,200 m (3,940 ft)	Metamorphic-grade quartzite and sillimanite schist		
	Metamorphosed black shale (Xbs2)	Thin-bedded, dark phyllite, biotite schist, or garnet schist, depending on metamorphic grade; maximum thickness 700 m (2,300 ft)	None		
	Metamorphosed carbonate-facies, iron-formation (Xif)	Banded metachert containing ankerite and siderite, and schist; average thickness about 25 m (80 ft)	Cummingtonite-grunerite and garnet; locally sulfide-rich and graphitic		