

Map Unit Properties Table: Pipe Spring National Monument

Colored rows indicate map units exposed within Pipe Spring National Monument.

Age	Unit Name (Symbol)	Features and Description	Erosion Resistance	Suitability for Development	Hazards	Paleontological Resources	Cultural Resources	Mineral Occurrence	Habitat	Recreation	Geologic Significance
QUATERNARY (Holocene)	Artificial fill and quarries (Qaf)	Alluvium and bedrock material used for stock tanks, drainage diversion dams, roads, or other construction projects other than highways. No map distinctions between quarried or filled excavations. Agricultural fields are not shown on the reference map. Mapped immediately adjacent to the monument's eastern boundary.	Low. Unconsolidated material.	Fill used for construction projects	None	None	None documented	None	Not applicable	Isolated, minor exposures in monument	None
	Stream-channel alluvium (Qs)	White to light-red, interbedded silt, sand, gravel, and pebbles; unconsolidated and poorly sorted. Mostly sandstone pebbles above the topographic position of <i>TRCs</i> , but below <i>TRC</i> the clasts are mostly black, well-rounded quartzite or chert pebbles of volcanic origin. Thickness: 1–4 m (3–12 ft).	Not exposed in Pipe Spring National Monument or within 2 km (1.2 mi) of the monument's boundaries.								
	Floodplain deposits (Qfp)	Light-red or tan silt, fine- to coarse-grained sand and lenses of pebble gravel. Partly cemented by gypsum or calcite. Locally contains yellow, red, black, and white subrounded to subangular chert fragments, well-rounded white quartzite, and gray-blue, rounded limestone pebbles 0.6–2 cm (0.25–0.75 in) in diameter. Gradational and arbitrary contact both laterally and vertically between <i>Qs</i> , <i>Qfp</i> , and <i>Qa1</i> deposits. Dense growths of tamarisk along drainages often trap sediment to form <i>Qfp</i> . Overlies and often grades laterally into <i>Qs</i> . Thickness: 1–6 m (3–20 ft).	Not exposed in Pipe Spring National Monument or within 2 km (1.2 mi) of the monument's boundaries.								
	Ponded sediments (Qps)	Light-red to white clay, mud, silt, and fine-grained sand. May include small fragments of bedrock from nearby outcrops. Includes deposits of sand and silt on Moccasin Mountain where widespread sand sheet and sand dunes form temporary dams across local drainages or in internal depressions formed within dunes. Also, found in Twomile Wash, east of Pipe Spring. Desiccation cracks often form on dry hardpan surfaces. Thickness: 0.3–2 m (1–6 ft).	Not exposed in Pipe Spring National Monument or within 2 km (1.2 mi) of the monument's boundaries.								
	Eolian sand sheet deposits (Qes)	Light-red to white silt and fine- to coarse-grained eolian (wind) sand derived from the Navajo Sandstone (<i>Jn</i>). Thick deposits over gently sloping terrain of <i>Jn</i> where sand fills large cracks and joints on the surface, allowing deep-rooted vegetation to develop growth patterns that follow the linear trend of the joints and cracks. Gradational and arbitrary contacts between <i>Qes</i> , <i>Qd</i> , and <i>Qae</i> deposits based on morphologic interpretation of aerial photos. Sand sheets, which lack the dune shape, often lead to fine-grained <i>Qd</i> accumulations on steep bedrock or <i>Ql</i> deposits along Vermilion Cliffs and other small isolated mesas and buttes where reduced wind speed allows sand accumulation. In Pipe Valley, south of State Hwy 389, <i>Qes</i> deposits are thin, widespread, and partly stabilized by grass, small high-desert shrubs, and lag gravel (coarse material left behind after winds blow away finer material) consisting mostly of black pebbles derived from the <i>TRCs</i> of Yellowstone Mesa. Thickness: 0.2–1 m (0.5–3 ft) in southern half of map and as much as 3–5 m (9–15 ft) in large valleys on Moccasin Mountain and within tributary canyons.	Not exposed in Pipe Spring National Monument or within 1 km (0.6 mi) of the monument's boundaries. Exposed between 1 km (0.6 mi) and 2 km (1.2 mi) southwest of the monument. Sand sheet deposits are widespread and common throughout the map area, but most are too thin to show at the scale of the reference map.								
	Eolian sand dune deposits (Qd)	Light-red to white, fine- to coarse-grained sand. Includes dunes on steep sloping topography. Gradational and arbitrary contact with <i>Qes</i> and <i>Qae</i> deposits. Surfaces commonly active in large open valley areas that support sparse growth of grass or small shrubs and on steep topography. Thickness: 4–11 m (12–35 ft).	Exposed less within 1 km (0.6 mi) north of the monument's boundaries. Not exposed within Pipe Spring National Monument.								
	Mixed eolian and fluvial deposits (Qae)	Gray, light-red and white silt and fine- to coarse-grained sand lenses interlayered with red-brown and gray silt and clay. Some coarse-grained gravel composed of angular chert fragments and red to white sub-rounded sandstone pebbles on Moccasin Mountain. Often overlapped by <i>Qes</i> or <i>Qd</i> deposits with map contacts based on aerial photography. Thickness: 1.5–18 m (5–60 ft).	Minor, relatively insignificant deposits are exposed within 1 km (0.6 mi) of the monument's boundaries. Not exposed in Pipe Spring National Monument								
	Valley fill alluvial deposits (Qv)	Gray to light-red, unsorted mixture of mud, silt, sand, gravel, small pebbles, and cobbles. Partly cemented by calcite and gypsum. Sandstone, limestone, and chert in sandy matrix locally derived from nearby Paleozoic and Mesozoic sedimentary rock outcrops in southeast quarter of reference map area. Similar to <i>Qs</i> deposits and commonly interlayered with <i>Qs</i> and <i>Qes</i> or <i>Qd</i> deposits. Contacts with other alluvial deposits are arbitrary and approximate. Thickness: 1–6 m (3–20 ft).	Not exposed in Pipe Spring National Monument or within 2 km (1.2 mi) of the monument's boundaries.								
	Talus and rock fall deposits (Qtr)	Includes silt, sand, and large to small broken rocks and boulders. Some boulders are as large as vehicles and up to house size near <i>Ql</i> deposits below Vermillion Cliffs. Gradational and arbitrary contact between <i>Ql</i> , <i>Qtr</i> , <i>Qa1</i> , <i>Qa2</i> , and <i>Qa3</i> deposits. Unit grades downslope into <i>Qa1</i> , <i>Qa2</i> , or <i>Qa3</i> deposits. Thickness: 1.5–14 m (5–45 ft).	Minor, relatively insignificant deposits are exposed approximately 2 km (1.2 mi) northwest of the monument. Not exposed in Pipe Spring National Monument								
	Young alluvial terrace-gravel deposits (Qg1)	Red, white, and gray interlayered fine- to coarse-grained sand and thinly laminated silt; partly cemented by gypsum and calcite. Thin beds of gray or red mud and clay and some lenses of gravel composed of gray, subangular chert fragments above outcrops of <i>TRC</i> . Gray-blue, subrounded limestone pebbles, and red, yellow, black, or white, well-rounded quartzite pebbles below outcrops of <i>TRCs</i> . Cut by modern arroyos up to 9 m (30 ft) deep in Moccasin Canyon and in other canyons eroded into the Vermillion Cliffs. Thickness: 1.2–15 m (4–50 ft) or more.	Not exposed in Pipe Spring National Monument or within 2 km (1.2 mi) of the monument's boundaries. Exposed in Moccasin Canyon, north of the monument.								

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Age	Unit Name (Symbol)	Features and Description	Erosion Resistance	Suitability for Development	Hazards	Paleontological Resources	Cultural Resources	Mineral Occurrence	Habitat	Recreation	Geologic Significance
QUATERNARY (Holocene)	Young alluvial fan deposits (Qa1)	Light-red, gray, and brown silt, fine- to coarse-grained interbedded sand and gravel; partly cemented by gypsum, calcite, and clay. Contains light-red to brown silt, red and white chert fragments and small red and white sandstone pebbles locally derived from outcrops of <i>Jk</i> and <i>Jn</i> below the Vermillion Cliffs. Includes boulders of <i>TRCs</i> up to 2 m (6 ft) in diameter near outcrops of <i>TRCs</i> below Yellowstone Mesa and Bitter Seeps Wash areas. Clay content greatest near Petrified Forest Member of <i>TRC</i> in Sandy Canyon Wash and Pipe Valley areas. Numerous black, brown, yellow, red, and gray, very well rounded quartzite and chert pebbles 1.3–5 cm (0.5–2 in) in diameter and rare, rounded, gray-white petrified wood fragments derived from <i>TRCs</i> . Locally covered by thin <i>Qes</i> and <i>Qae</i> or <i>Qd</i> deposits at distal ends of fans. Commonly overlapped by or interlayered with <i>Qs</i> deposits. All deposits below the Vermillion Cliffs are composed of sediment from Triassic and Jurassic strata. Thickness: 1.5–12 m (5–40 ft).	Low. Only partly consolidated and subject to extensive sheetwash (sheet erosion) during heavy storms.	Suitable for roads, buildings, and other infrastructure.	Sheet-wash during storms.	None	Contains pioneer ruins and possible American Indian sites.	Sand and gravel	Supports moderate growth of grass, sagebrush, and various small high-desert shrubs.	Suitable for most uses, including hiking, picnicking, camping.	Forms fan shaped alluvial deposits at base of <i>Jn</i> and <i>Jk</i> cliffs.
QUATERNARY (Pleistocene–Holocene)	Intermediate alluvial terrace-gravel deposits (Qg2)	Gray, light-red to brown, thin-to massive-bedded, interlayered clay, silt, and fine-to coarse-grained sand similar to <i>Qg1</i> deposits; partly cemented by clay and gypsum. Interlayered with <i>Qa1</i> and <i>Qa2</i> along Bulrush Wash. Gradational and arbitrary contact with <i>Qa1</i> and <i>Qa2</i> . Thickness: 2.4–9 m (8–30 ft).	Not exposed in Pipe Spring National Monument or within 2 km (1.2 mi) of the monument’s boundaries.								
	Intermediate alluvial fan deposits (Qa2)	Similar to <i>Qa1</i> deposits. Partly cemented by calcite, clay, and gypsum below stratigraphic level of <i>TRC</i> ; mostly unconsolidated above <i>TRC</i> . Commonly overlapped by <i>Qa1</i> and <i>Qs</i> . Interlayered with <i>Qg2</i> near distal ends of fans. Interlayered with <i>Ql</i> and <i>Qtr</i> at upper reaches of alluvial fans below Vermillion Cliffs where unit is heavily dissected by erosion. Thickness: 2–14 m (6–45 ft).	Exposed between 1 km (0.6 mi) and 2 km (1.2 mi) northwest of the monument. Not exposed in Pipe Spring National Monument.								
	Landslide debris deposits (Ql)	Detached blocks of strata that have rotated backward and slid downslope as loose, incoherent masses of broken rock and deformed strata, often surrounded by <i>Qtr</i> debris. Often covered in part by <i>Qes</i> and <i>Qd</i> . May overlie claystone or siltstone bedrock of Petrified Forest Member of <i>TRC</i> or lower part of <i>Jk</i> . Thickness: 8–61 m (25–200 ft).	Exposed in isolated outcrops along the base of the cliff within 1 km (0.6 mi) west of the monument. Not exposed in Pipe Spring National Monument								
QUATERNARY (Pleistocene)	Old alluvial terrace-gravel deposits (Qg3)	Gray and light-brown to light-red clay, silt, and sand similar to <i>Qg1</i> and <i>Qg2</i> . Locally contains lenses of small pebble gravel and conglomerate composed of white and red, rounded sandstone, blue-gray rounded limestone, sub-rounded white chert, and scattered well-rounded multicolored quartzite pebbles in fine- to coarse-grained gravel matrix. Often covered by thin sand sheet deposits. Thickness: 3–6 m (10–20 ft).	Not exposed in Pipe Spring National Monument or within 2 km (1.2 mi) of the monument’s boundaries.								
	Old alluvial fan deposits (Qa3)	Silt, sand, gravel, cobbles, and boulders of sandstone locally derived from <i>Jk</i> or <i>Jn</i> . Similar to <i>Qa1</i> and <i>Qa2</i> ; stony surface where not covered by <i>Qd</i> along the base of Vermillion Cliffs in the northeast quarter of the reference map. Contributes material to <i>Qa1</i> and <i>Qa2</i> . Interlayered with <i>Qtr</i> and <i>Ql</i> . Adjacent to or overlapped by <i>Qa1</i> and <i>Qa2</i> , <i>Qes</i> , and <i>Qd</i> . Thickness: 3–15 m (10–50 ft).	Not exposed in Pipe Spring National Monument or within 2 km (1.2 mi) of the monument’s boundaries.								
QUATERNARY and TERTIARY (Pliocene–Pleistocene)	Oldest alluvial terrace-gravel deposits (QTg4)	Lithologically similar to <i>Qg1</i> , <i>Qg2</i> , and <i>Qg3</i> . Deposits are partially preserved in abandoned meander loops of streams or isolated abandoned point bars (ridges of sand and gravel developed on the inside of a stream’s growing meander bend) in southeast quarter of the reference map. Thickness: 2–6 m (6–20 ft).	Not exposed in Pipe Spring National Monument or within 2 km (1.2 mi) of the monument’s boundaries.								
REGIONAL UNCONFORMITY The unconformity represents at least 170 million years of missing geologic time between the Early Jurassic and Pliocene epochs.											
JURASSIC (Lower)	Navajo Sandstone* (Jn)	White to light-red and yellow-gray, medium-cross-bedded to thickly-cross-bedded, well-sorted, fine-to coarse-grained eolian quartz sandstone interbedded with dark-red, coarse-grained sandstone and siltstone in lower part. Lower part is red; upper part is white. Lenses of dark purple to gray, thin-bedded, calcareous sandstone are freshwater deposits within and between coastal sand dunes. High-angle, cross-bedded sandstone sets interlayered with low-angle, cross-bedded sandstone and thin flat-bedded sandstone sets. Commonly covered by thin to thick <i>Qes</i> , <i>Qd</i> , or <i>Qae</i> deposits. <i>Jn</i> and <i>Jk</i> strata dip 8° east at Moccasin Canyon and just northwest of Pipe Spring National Monument. Highly fractured by near vertical northeast-, northwest-, and north-south-oriented bedrock joints. Joints parallel to the Moccasin Monocline dip west or southwest as much as 82°. Near vertical joints in upper Moccasin Canyon where strata are nearly horizontal means that the joints likely developed prior to development of the Moccasin Monocline. Contact with underlying <i>Jkt</i> placed at base of <i>Jn</i> cliff at Moquith Mountain and <i>Jk</i> elsewhere. Incomplete section due to removal of top part by modern erosion. Thickness about 460 m (1,500 ft). Thickens north of map area to as much as 610 m (2,000 ft).	High. Forms towering cliffs wherever it outcrops on the Colorado Plateau.	Low. Relatively steep topography; isolated to northwest section of the monument. Forms cliffs of Moccasin Monocline.	Potential rockfall and cliff collapse if softer <i>Jk</i> is eroded and cliff is undercut, especially where local joints parallel the Vermillion Cliffs.	<i>Eubrontes</i> dinosaur tracks present within the park.	Possible American Indian sites.	None documented in Pipe Spring National Monument.	Pinion and juniper trees, cliff-rose bush; sagebrush, various high-mountain shrubs and grasses on Moccasin and Moquith mountains.	Suitable for most uses, including hiking (Ridge Trail), picnicking, camping.	Renown for extraordinary cross-bedded sandstone representing a vast Jurassic sand sea. Forms the cliffs of the Moccasin Monocline. Major regional aquifer.

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JURASSIC (Lower)	Tenney Canyon Tongue of the Kayenta Formation (Jkt)	Dark-red to light red-brown, very fine-grained, thin-bedded to laminated, fluvial siltstone and sandstone. Ledges of dark-red sandstone in upper part. Interlayered laterally with Jnl. Locally, forms a sharp horizontal contact at the top of Jnl cliff. At Moquith (Moki) Mountain, the contact is marked by a color contrast between the dark-red siltstone and sandstone of <i>Jkt</i> and the white and light-red sandstone of <i>Jnl</i> . Thickens from 37 m (120 ft) at Kanab, UT, to 67 m (220 ft) at Ed Lamb Point, Moquith Mountain, 13 km (8 mi) northeast of Kaibab and Moccasin, AZ. Becomes upper part of <i>Jk</i> where <i>Jnl</i> pinches out west and south of Moquith Mountain. Not mapped in the monument, but exposures may be too thin to map at the reference map's scale. Thickness in Moquith Mountain area is 67 m (220 ft).	Moderate. Forms both slopes and thin sandstone ledges. Siltstone less resistant to erosion than sandstone.	Low. Forms thin lenses of sandstone and siltstone at <i>Jn/Jk</i> contact. Too thin to be significant.	None documented on reference map	None documented on reference map	None documented. Limited aerial extent. May not be exposed in the monument.	None documented. Limited aerial extent. May not be exposed in the monument.	Limited aerial extent. May not be exposed in the monument.	Limited aerial extent. May not be exposed in the monument.	Represents a return to fluvial deposition in the transition from the Kayenta to the vast Navajo Sandstone dune environment.
	Lamb Point Tongue of the Navajo Sandstone* (Jnl)	Gray-white to orange-brown, very fine-grained to fine-grained, cross-bedded quartz sandstone of eolian origin. Top 3–4.5 m (10–15 ft) east of Ed Lamb Point locally shows beds that deformed at the time of deposition beveled by overlying <i>Jkt</i> . Both a gradual and sharp contact with underlying <i>Jk</i> (marked at base of white and red sandstone cliff of <i>Jnl</i>). Thickness is 120 m (400 ft) near Kanab, UT; thins south and west to 43 m (140 ft) at Moquith Mountain; mostly a red sandstone cliff about 30 m (100 ft) thick near Point Spring of Vermillion Cliffs, 3 km (2 mi) north of Moccasin and Kaibab, AZ. Forms an elongated 1.6 km-wide (1 mi) tongue of sandstone that extends southwest from Ed Lamb Point to Moccasin Mountain, 3 km (2 mi) north of Kaibab, AZ, and pinches out as a red sandstone ledge in Vermillion Cliffs, 1.6 km (1 mi) west of the monument. Not mapped in Pipe Spring National Monument, but exposures may be too thin to map at the scale of the reference map*.	High. Forms cliff of white and red cross-bedded <i>Jn</i> within upper part of <i>Jk</i> along Vermillion Cliffs from Moquith Mts east to Kanab, UT.	Low. Relatively steep topography; isolated to northwest section of the monument. Forms cliffs of Moccasin Monocline.	Potential rockfall and cliff collapse if softer <i>Jk</i> is eroded and cliff is undercut, especially where local joints parallel the Vermillion Cliffs.	None documented on reference map	Possible American Indian sites.	None documented in Pipe Spring National Monument.	Pinion and juniper trees, cliff-rose bush; sagebrush, various high-mountain shrubs and grasses on Moccasin and Moquith mountains.	Suitable for most uses, including hiking (Ridge Trail), picnicking, camping.	Originally defined (type locality) at Ed Lamb Point, 13 km (8 mi) northeast of Moccasin and Kaibab, AZ. Is a local aquifer north and east of Pipe Spring.
	Kayenta Formation (Jk)	Dark-red and light red-brown, calcareous mudstone, siltstone, and sandstone. Often covered by <i>Ql</i> and <i>Qtr</i> deposits along lower part of Vermillion Cliffs. Forms slopes below <i>Jn</i> cliff. Thickness increases from 82 m (270 ft) at Ed Lamb Point to nearly 120 m (400 ft) at Potter Canyon at the expense and loss of <i>Jnl</i> southwest of Moccasin Mountain.	Moderate. Less resistant than overlying <i>Jnl</i> .	Low. Forms steep slopes; landslide blocks of <i>Jn</i> .	Erosion may undercut <i>Jn</i> and cause cliff collapse	Dinosaur tracks documented elsewhere in <i>Jk</i> .	Possible American Indian sites. Building stones for Winsor Castle and other structures.	None documented in the monument.	Sparse vegetation.	Hiking trails (Ridge Trail).	Ancient fluvial, playa, and shallow lake environments.
	Moenave Formation (Jm, Jms, Jmw, Jmd)	<p><i>Jm</i>: Includes, in descending order, the Springdale Sandstone Member (<i>Jms</i>), Whitmore Point Member (<i>Jmw</i>), and Dinosaur Canyon Member (<i>Jmd</i>). Not exposed in Pipe Spring National Monument.</p> <p><i>Jms</i>: Light-red to red-brown, thin- to thick-bedded sandstone and lenses of conglomerate. Includes low-angle trough cross-bed sets of fluvial sandstone. Contains dark red mudstone and siltstone rip-up clasts and poorly preserved petrified and carbonized fossil plant remains. Dark red, thin-bedded to laminated, siltstone and mudstone beds that locally contain mudstone pellets separate cross-beds. Grades into underlying <i>Jmw</i>. Thickens north and east of the reference map to about 61 m (200 ft) at Kanab, UT; thins southward and intertongues with lower part of <i>Jk</i>. Thickness near Monument is 36–52 m (120–170 ft).</p> <p><i>Jmw</i>: Red-brown sandstone and siltstone interbedded with red-purple to green-gray and blue mudstone, claystone, and thin gray dolomitic limestone. Limestone contains small red-brown chert nodules, poorly preserved fossil algal structures, and fish scales and bones near Zion National Park, north of reference map area. Grades into underlying <i>Jmd</i>. Contact is marked by distinct color contrast of blue-green, green, and yellow mudstone and siltstone of <i>Jmw</i> to red-brown siltstone and sandstone of underlying <i>Jmd</i>. Thickness 18–24 m (60–80 ft).</p> <p><i>Jmd</i>: Red-brown, thin-bedded, very fine-grained sandstone and silty sandstone. Gradually thickens west to east. About 61 m (200 ft) thick at Kanab, UT. Thickness: 36–61 m (120–200 ft).</p>	Not exposed in Pipe Spring National Monument or within 2 km (1.2 mi) of the monument's boundaries.								
<p>REGIONAL UNCONFORMITY</p> <p>Approximately 10 million years are missing between the Chinle Formation and the Moenave Formation.</p>											

* The interpretation of the Navajo Sandstone in the northwest corner of the monument by Billingsley and others (2004) as the main body of the Navajo Sandstone (Jn) is preferred over the description in Sharrow (2009) as the Lamb Point tongue (Jnl).

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TRIASSIC (Upper)	Chinle Formation (TRc, TRcp, TRcs)	<p>TRc: Includes, in descending order, the Owl Rock and Petrified Forest Members, undivided (TRcp) and Shinarump Member (TRcs). The Owl Rock Member of the TRc is present at the south end of the Moquith Mountain, northeast corner of the map and gradually thins to the west and southwest and overlies the Petrified Forest Member.</p> <p>TRcp: Owl Rock Member: Light-red and white, coarse-grained sandstone and gray, fine-grained sandstone and siltstone interlayered with thin-bedded (13 cm–0.6 m; 5 in–2 ft) gray-white, siliceous, limestone beds. Limestone contains red and white chert nodules. Thickness is 12 m (40 ft) at Kanab, UT; thins to less than 9 m (30 ft) at Ed Lamb Point. Gradual transition into the upper part of the Petrified Forest Member throughout the reference map. Petrified Forest Member: Gray, light-purple, blue, light- to dark-red, claystone, siltstone, and white, coarse-grained sandstone. Includes petrified wood and calcite nodules in the Blue Knolls area. Units mostly covered by Quaternary deposits. Gradual transition (vertical and lateral) to underlying TRcs. Multicolored mudstone and siltstone interlayer with white, gritty sandstone and conglomerate of TRcs. Thickness: 180–210 m (600–700 ft).</p> <p>TRcs: White to yellow-brown, thin- to thick-bedded, coarse-grained, low-angle cross-bedded sandstone, gravel, and conglomeratic sandstone. Numerous small channel lenses and pockets of small pebble conglomerate composed of well rounded to subrounded, multicolored quartz, quartzite, and black chert pebbles (dominant pebble) in a gravely sandstone matrix. Pebbles average 2.5–5.1 cm (1–2 in) in diameter and include some well-rounded quartzite cobbles as much as 25 cm (10 in) in diameter. Black pebbles form a desert pavement of lag gravel on all alluvial fan surfaces around Yellowstone Mesa, southwest quarter of the map. Thickness: 6–38 m (20–125 ft).</p>	Not exposed in Pipe Spring National Monument or within 2 km (1.2 mi) of the monument’s boundaries.								
		REGIONAL UNCONFORMITY									
TRIASSIC (Middle? and Lower)	Moenkopi Formation (TRm, TRmu)	<p>TRm₂: Includes, in descending order, Upper Red Member (TRmu), Shnabkaib Member (TRms), Middle Red Member (TRmm), Virgin Limestone Member (TRmv), and Lower Red Member and Timpoweap Member, undivided (TRml).</p> <p>TRmu: Light-red and dark-red siltstone and sandstone. Gradual transition to the underlying TRms. Contact placed arbitrarily at top of highest thick white siltstone and dolomite bed of TRms. Siltstones form slopes; sandstones form ledges. Small cliffs in upper part. Thickness: 49 m (160 ft).</p>	TRmu is not exposed in Pipe Spring National Monument or within 2 km (1.2 mi) of the monument’s boundaries.								
TRIASSIC (Lower)	Moenkopi Formation (TRm, TRms, TRmm)	<p>TRms: White to light gray, laminated to thinly bedded, fine-grained dolomite with light-gray, calcareous, silty gypsum. Light red, thinly-bedded mudstone, siltstone, and sandstone in lower and upper parts. Gradual transition to underlying TRmm. Contact placed at lowest, thick bed of white or light-gray, calcareous TRms siltstone and dolomite. Thickens northwest of the reference map; thins to the southeast. Exposed east of the monument on tribal lands including the site of the monument’s administrative offices. Thickness: 27–34 m (90–110 ft).</p> <p>TRmm: Red-brown, thin-bedded to laminated siltstone and sandstone. Includes thin veinlets and stringers of gypsum deposited in fractures and cracks throughout unit. Minor beds of white, laminated dolomite, green siltstone, and gray-green to red mudstone that contains gypsum. Mudcracks and ripple marks common throughout. The gradual transition of the lower contact with TRmv is placed at the top of highest gray limestone bed of TRmv. Forms slopes and is exposed in the northeast corner of the monument. Thickness: 85–91 m (280–300 ft).</p>	Variable. Dolomite and sandstone more resistant than gypsum, siltstone, and mudstone.	Contains roads, buildings, and other infrastructure, but gypsum-containing deposits lack strength and are subject to dissolution and collapse.	None documented in Pipe Spring National Monument.	None documented in Pipe Spring National Monument.	Possible American Indian sites.	None documented in Pipe Spring National Monument.	Sparse vegetation (sagebrush and other semi-arid plants)	Suitable for most uses.	Deposits represent a mix of fluvial, mudflat, sabkha, and shallow marine environments that developed from eastern Utah to eastern Nevada in the Early Triassic.

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SUBSURFACE UNITS THAT ARE NOT EXPOSED WITHIN PIPE SPRING NATIONAL MONUMENT BUT ARE SHOWN ON CROSS-SECTIONS B-B' AND C-C'											
TRIASSIC (Lower)	Moenkopi Formation (TRm, TRmv, TRml)	<p>TRmv: Two light-gray, thin-bedded to laminated, ledge-forming limestone beds (0.3–1 m; 1–3 ft thick) separated by pale-yellow, light-red, and bluish-gray, thin-bedded to massive, slope-forming gypsiferous (containing gypsum) siltstone (bulk of unit). Surface of erosion separates lower gray limestone from underlying dark red siltstone and sandstone of TRml with erosional relief as much as 1.2 m (4 ft). Exposed on the surface in the southern part of the reference map. Thickness: 37 m (120 ft).</p> <p>TRml: Dark-red, thin-bedded, fine-grained, gypsiferous, sandy siltstone, sandstone, and pale-yellow to gray, laminated, silty gypsum. Gypsum, siltstone, and sandstone in lower part derived from erosion of Pkh. Lower part has a 1–2 m (3–7 ft) thick, ledge-forming, red-gray to light purple-red, coarse-grained, low-angle cross-bedded, calcareous sandstone that forms a prominent marker bed, or key layer used to trace strata from one place to another. Exposed on the surface in the southern section of the reference map. Thickness: 37–55 m (120–180 ft).</p>	Not exposed in Pipe Spring National Monument or within 2 km (1.2 mi) of the monument's boundaries.								
		REGIONAL UNCONFORMITY									
PERMIAN (Lower)	Kaibab Formation (Pk, Pkh, Pkf)	<p>Pk: Includes, in descending order, Harrisburg Member (Pkh) and Fossil Mountain Member (Pkf). Only Pkh is shown on cross-section B-B', which crosses Pipe Spring National Monument.</p> <p>Pkh: Red and gray, interbedded, gypsiferous siltstone, sandstone, gypsum, and gray, thin-bedded limestone. Calcite and gypsum matrix cement in upper part. Limestone beds as much as 4 m (14 ft) thick consist of gray, thin-bedded, cherty limestone weathering dark brown or black and a light-gray, thin-bedded, sandy limestone. Limestone beds thicken and thin laterally. Gradual transition to the underlying Pkf. Contact marked at top of cherty limestone bed of Pkf. Thickness: 49 m (160 ft).</p> <p>Pkf: Light-gray, fine- to medium-grained, thin-bedded, fossiliferous, sandy, cherty limestone. Characterized by white, thin-bedded, chert beds and nodules in sandy cliff-forming limestone. Thickness: 76 m (250 ft).</p>	Not exposed in Pipe Spring National Monument or within 2 km (1.2 mi) of the monument's boundaries. Surface exposures mapped in the southeast section of the reference map.								
		<p>Includes, in descending order, Woods Ranch Member (Ptw), Brady Canyon Member (Ptb), and Seligman Member (Pts). Units are exposed in Kanab Canyon just south of the reference map.</p> <p>Ptw: Gypsiferous siltstone and pale-red silty sandstone interlayered with white, laminated gypsum. Beds are locally distorted because of the dissolution of gypsum. Gradual transition to underlying Ptb. Thickness varies from 55 to 81 m (180 to 265 ft) because of the dissolution of gypsum.</p> <p>Ptb: Gray, medium-bedded, fine- to coarse-grained, fetid, fossiliferous limestone; weathers dark gray. Thin-bedded dolomite in upper and lower parts. Limestone beds average 0.3–0.6 m (1–2 ft) thick and include chert lenses and nodules. Gradational lower contact with underlying Pts. Contact commonly covered by minor slump or talus debris. Thickness: 70 m (230 ft).</p> <p>Pts: Gray, thin-bedded dolomite and gypsiferous sandstone. Middle part includes gray to red, thinly interlayered siltstone, sandstone, and gypsum and cross-bedded sandstone. Lower part includes brown, purple, and yellow, fine- to medium-grained, thin-bedded, low- to high-angle cross-bedded and planar-bedded sandstone that is mostly covered by talus debris. Thickness: 52 m (170 ft).</p>	Not exposed in Pipe Spring National Monument or within 2 km (1.2 mi) of the monument's boundaries. Exposed in Kanab Canyon just south of the reference map.								

Reference map: Billingsley, G. H., S. S. Priest, and T. J. Felger. 2004. *Geologic map of Pipe Spring National Monument and the western Kaibab- Paiute Indian Reservation, Mohave County, Arizona*. Scale 1:31,680. U.S. Geological Survey, Scientific Investigation Map 2863. <http://pubs.usgs.gov/sim/2004/2863/>.