

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



Pipe Spring National Monument

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic Data for Pipe Spring National Monument

[pisp_geology.pdf](#)

Version: 9/15/2021

Geologic Resources Inventory Map Document for Pipe Spring National Monument

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Geologic Resources Inventory Map Document



Pipe Spring National Monument, Arizona

Document to Accompany Digital Geologic-GIS Data

[pisp_geology.pdf](#)

Version: 9/15/2021

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Pipe Spring National Monument, Arizona (PISP).

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 Map and Source Citation** – The GRI digital geologic-GIS map produced for this project along with source map used in its completion. In addition, a brief explanation of how the source map was used is provided.
- 3) **Map Unit List** – A listing of all geologic map units present on the map for this project, generally listed from youngest to oldest.
- 4) **Map Unit Descriptions** – Descriptions for all geologic map units.
- 5) **Geologic Cross Sections** – Geologic cross section graphics with source geologic cross section abbreviations.
- 6) **Ancillary Source Map Information** – Additional source map information including a correlation of map units and a legend.
- 7) **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

The Geologic Resources Inventory (GRI) provides geologic map data and pertinent geologic information to support resource management and science-informed decision making in more than 270 natural resource parks throughout the National Park System. 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 GRI is one of 12 inventories funded by the National Park Service (NPS) Inventory and Monitoring Program. The Geologic Resources Division of the NPS Natural Resource Stewardship and Science Directorate administers the GRI. The NPS Geologic Resources Division partners with the Colorado State University Department of Geosciences to produce GRI products. Many additional partners participate in the GRI process by contributing source maps or reviewing products.

The GRI team undertakes three tasks for each park in the Inventory and Monitoring program: (1) conduct a scoping meeting and provide a summary document, (2) provide digital geologic map data in a geographic information system (GIS) format, and (3) provide a GRI report. These products are designed and written for nongeoscientists.

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 Map and Source Map Citation

The GRI digital geologic-GIS map for Pipe Spring National Monument, Arizona (PISP):

Digital Geologic-GIS Map of Pipe Spring National Monument and Vicinity, Arizona (*GRI MapCode PISP*)

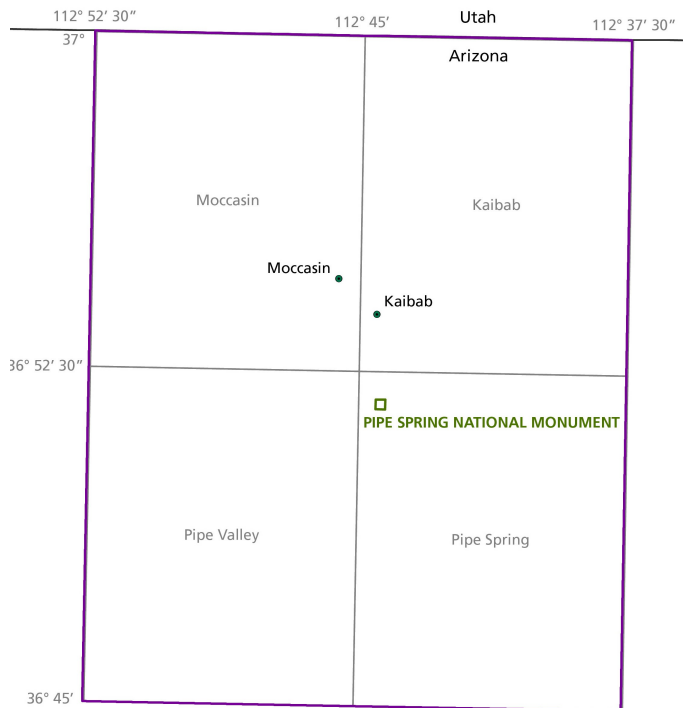
The above digital geologic-GIS map was produced from the following source map listed below. The full extent of the source map was used and all geologic features within the extent were captured.

Billingsley, G.H., Priest, S.S., and Felger, T.J., 2005, Geologic Map of Pipe Spring National Monument and the Western Kaibab-Paiute Indian Reservation, Mohave County, Arizona: U.S. Geological Survey, SIM-2863, scale 1:100,000 ([Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)). (*GRI Source Map ID 5407*).

Additional information pertaining to each source map is also presented in the GRI Source Map Information (PISPMAP) table included with the GRI geologic-GIS data.

Index Map

The following index map displays the extent of the GRI digital geologic-GIS map (in purple) produced for Pipe Spring National Monument (PISP). The boundary for Pipe Spring National Monument (as of September, 2021) is outlined in green. The four 7.5' quadrangles that comprise the map are also shown (in gray), as are the longitude and latitude coordinates that bound these quadrangles. The towns of Moccasin and Kaibab are also shown, as is the state boundary between Arizona and Utah.



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

Map Unit List

The geologic units present in the digital geologic-GIS data produced for Pipe Spring National Monument, Arizona (PISP) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Qaf - Artificial fill and quarries). Units are listed from youngest to oldest. Information about each geologic unit is also presented in the GRI Geologic Unit Information (PISPUNIT) table included with the GRI digital geologic-GIS data.

Cenozoic Era

Quaternary Period

[Qaf](#) - Artificial fill and quarries
[Qs](#) - Stream-channel alluvium
[Qfp](#) - Floodplain deposits
[Qps](#) - Ponded sediments
[Qes](#) - Eolian sand sheet deposits
[Qd](#) - Eolian sand dune deposits
[Qae](#) - Mixed eolian and fluvial deposits
[Qv](#) - Valley fill alluvial deposits
[Qtr](#) - Talus and rock fall deposits
[Qg1](#) - Young alluvial terrace-gravel deposits
[Qa1](#) - Young alluvial fan deposits
[Qg2](#) - Intermediate alluvial terrace-gravel deposits
[Qa2](#) - Intermediate alluvial fan deposits
[Ql](#) - Landslide debris deposits
[Qg3](#) - Old alluvial terrace-gravel deposits
[Qa3](#) - Old alluvial fan deposits

Quaternary and Tertiary Periods

[QTg4](#) - Oldest alluvial terrace-gravel deposits

Mesozoic Era

Jurassic Period

[Jn](#) - Navajo Sandstone
[Jnl](#) - Navajo Sandstone, Lamb Point Tongue
[Jk](#) - Kayenta Formation
[Jkt](#) - Kayenta Formation, Tenney Canyon Tongue
[Moenave Formation](#)
[Jms](#) - Moenave Formation, Springdale Sandstone Member
[Jmw](#) - Moenave Formation, Whitmore Point Member
[Jmd](#) - Moenave Formation, Dinosaur Canyon Member

Triassic Period

[Chinle Formation](#)

[TRcp](#) - Chinle Formation, Owl Rock and Petrified Forest Members, undivided
[TRcs](#) - Chinle Formation, Shinarump Member

[Moenkopi Formation](#)

[TRmu](#) - Moenkopi Formation, upper red member
[TRms](#) - Moenkopi Formation, Shnabkaib Member
[TRmm](#) - Moenkopi Formation, middle red member
[TRmv](#) - Moenkopi Formation, Virgin Limestone Member
[TRml](#) - Moenkopi Formation, lower red member and Timpoweap Member, undivided

Paleozoic Era

Permian Period

[Kaibab Formation](#)

[Pkh](#) - Kaibab Formation, Harrisburg Member

[Pkf](#) - Kaibab Formation, Fossil Mountain Member

[Toroweap Formation](#)

[Ptw](#) - Toroweap Formation, Woods Ranch Member (in cross section only)

[Ptb](#) - Toroweap Formation, Brady Canyon Member (in cross section only)

[Pts](#) - Toroweap Formation, Seligman Member (in cross section only)

Map Unit Descriptions

Descriptions of all geologic map units, generally listed from youngest to oldest, are presented below.

Qaf - Artificial fill and quarries (Holocene)

Alluvium and bedrock material removed from quarries and trench excavations to build stock tanks, drainage diversion dams, roads, or other manmade construction projects other than modern highways. No map distinctions between cut or fill excavations. Agricultural fields are not shown. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Qs - Stream-channel alluvium (Holocene)

White to light-red interbedded silt, sand, gravel, and pebbles; unconsolidated and poorly sorted. Pebbles and some cobbles are mostly sandstone above the topographic position of the Shinarump Member of the Chinle Formation; below the Chinle, clasts are dominated by black, well-rounded pebbles of quartzite or chert of volcanic origin. Locally overlaps or is deposited adjacent to young and intermediate alluvial terrace-gravel deposits ([Qg1](#), [Qg2](#)) and commonly overlaps young and intermediate alluvial fan ([Qa1](#), [Qa2](#)) deposits. Gradational and arbitrary contacts with other surficial alluvial or eolian deposits are approximate and subject to change. Stream channels are subject to intermittent high-energy flash floods that can produce local sediment accumulation on floodplain ([Qfp](#)) and young terrace alluvial ([Qg1](#)) deposits and widespread sediment accumulations on young alluvial fan ([Qa1](#)) deposits. Stream-channel alluvium is a common source for local sand dune or sand sheet accumulations in Pipe Valley and Sandy Canyon Wash areas. Little or no vegetation in stream channels except for occasional tamarisk trees or willow trees and grass. Thickness, 3 to 12 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Qfp - Floodplain deposits (Holocene)

Light-red or tan silt, fine- to coarse-grained sand, and lenses of pebble gravel; partly consolidated by gypsum or calcite cement. Gravel locally contains yellow, red, black, and white subrounded to subangular chert fragments, well-rounded white quartzite, and gray-blue, rounded limestone pebbles $\frac{1}{4}$ to $\frac{3}{4}$ inch in diameter. Seasonal floods may produce fresh deposits that generally accumulate temporary deposits on point bars of drainages, on young alluvial terrace-gravel ([Qg1](#)) deposits, and on flatland areas adjacent to young alluvial fan ([Qa1](#)) deposits when drainages are clogged by debris flows or man-made obstructions. Gradational and arbitrary contact both laterally and vertically between stream-channel ([Qs](#)), floodplain ([Qfp](#)), and young alluvial fan ([Qa1](#)) deposits. Support thick growth of tamarisk trees and other water-dependent plants where stream bedrock is very shallow, usually less than 10 ft to bedrock. Dense growths of tamarisk often help trap and accumulate sediment to form floodplain deposits within and along drainages. Deposits are generally 3 to 6 ft above stream-channel ([Qs](#)) deposits and often grade laterally into stream-channel deposits. Thickness, 3 to 20 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Qps - Ponded sediments (Holocene)

Light-red to white clay, mud, silt, and fine-grained sand. Locally include small angular to subrounded fragments of bedrock from nearby rock outcrops. Sediment accumulates in temporarily ponded areas on young and intermediate alluvial terrace-gravel ([Qg1](#), [Qg2](#)) deposits due to temporary sand dune accumulations or overbank sand levee deposits that prevent sediments from eroding back into local drainages for an extended amount of time. Includes ponded deposits consisting mostly of sand and silt on Moccasin Mountain where widespread sand sheet and sand dunes form temporary dams

across local drainages or as internal dunal depressions formed within dunes. South of Pipe Spring National Monument, ponded deposits accumulate in lowland areas where artificial diversion dams, stock tanks, or small sand dunes block drainage. Desiccation cracks often form on dry hardpan surfaces. Clay and fine silt largely restrict plant growth. Thickness, 1 to 6 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Qes - Eolian sand sheet deposits (Holocene)

On Moccasin and Moquith Mountains above Vermilion Cliffs, light-red to white silt and fine- to coarse-grained eolian sand derived from the Navajo Sandstone ([Jn](#)). Forms thick deposits over gently sloping terrain of Navajo Sandstone where sand fills large cracks and joints on the surface of Navajo allowing deep-rooted vegetation to develop linear growths on sand sheet or sand dune ([Qd](#)) deposits. Only most extensive and thickest deposits on Moccasin Mountain are shown; map contacts are arbitrary and gradational between sand sheet ([Qes](#)), sand dune ([Qd](#)), and mixed eolian and fluvial ([Qae](#)) deposits and are based on morphologic interpretation on aerial photos. Below Vermilion Cliffs, deposits accumulate along local stream drainages and on gentle slopes of young and intermediate alluvial fan ([Qa1](#), [Qa2](#)) deposits. Unit forms coarse-grained sand ramps on gentle slopes of the Shinarump Member of the Chinle Formation where the Shinarump is the sand source. Deposit often leads to fine-grained climbing or falling sand dune ([Qd](#)) accumulations on steep bedrock or landslide ([Ql](#)) deposits along Vermilion Cliffs and other small isolated mesas and buttes where wind speed is reduced to allow sand accumulation. In Pipe Valley south of State Highway 389, sand sheet deposits are thin, widespread, and partly stabilized by grass and small high-desert shrubs during wet conditions on young alluvial fan ([Qa1](#)) deposits; also stabilized by lag gravel consisting mostly of black pebbles derived from the Shinarump Member of the Chinle Formation of Yellowstone Mesa. Sand sheet veneer deposits are widespread and common through the map area but most are too thin to show. Support moderate growths of grass, black brush, and other small high-desert shrubs above Vermilion Cliffs, mostly grass below Vermilion Cliffs. Thickness, 0.5 to 3 ft in south half of map; as much as 9 to 15 ft in large valleys on Moccasin Mountain and within tributary canyons eroded into Moccasin Mountain. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Qd - Eolian sand dune deposits (Holocene)

Light-red to white, fine- to coarse-grained sand. Form complex lumpy dune shapes and random dune accumulations on variable sloping topography. Include climbing or falling dunes on steep sloping topography along Vermilion Cliffs. Arbitrary and gradational contact with sand sheet ([Qes](#)) and mixed eolian and fluvial ([Qae](#)) deposits are based on aerial photography interpretation. Dune surfaces are commonly active in large open valley areas that support sparse growth of grass or small shrubs and on steep topography. Unit is partly stabilized by grassy vegetation or by crypto-organic soil growths in local canyon drainage areas below Vermilion Cliffs. Thickness, 12 to 35 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Qae - Mixed eolian and fluvial deposits (Holocene)

Composed of gray, light-red, and white silt and fine- to coarse-grained eolian and fluvial sand lenses interbedded with red-brown and gray silt and clay. Include some coarse-grained gravel composed of angular chert fragments and red to white sub-rounded sandstone pebbles on Moccasin Mountain. Below Vermilion Cliffs, southeast half of map area, include multicolored, well-rounded quartzite pebbles derived from the Shinarump Member of the Chinle Formation. Commonly occupy upper slopes of young and intermediate alluvial fan ([Qa1](#), [Qa2](#)) deposits. Below Vermilion Cliffs, northwest quarter of map area, mostly composed of white and light-red sandstone and red siltstone that forms young alluvial fan deposits but deposits are dominated by interbedded mixed fluvial and eolian deposits in Parashont and Woodberry Canyons. Often overlapped by surficial sand sheet ([Qes](#)) or sand dune ([Qd](#)) deposits with arbitrary or approximate map contacts based on aerial photo interpretations. Support thick to moderate growths of grass, cactus, and some sagebrush below

Vermilion Cliffs; sagebrush, oak brush, cliffrose bush, pinion pine, oak, and juniper trees above Vermilion Cliffs. Thickness, 5 to 60 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Qv - Valley fill alluvial deposits (Holocene)

Gray to light-red, slope-forming, unsorted mixture of mud, silt, sand, gravel, small pebbles, and cobbles. Partly consolidated by calcite and gypsum cement. Sandstone, limestone, and chert in sandy matrix is locally derived from nearby Paleozoic and Mesozoic sedimentary rock outcrops in southeast quarter of map area. Similar to stream-channel ([Qs](#)) deposits but occupy low-gradient drainages that deposit mostly fine-grained sand or silt over nearly flat drainage floor. Similar to or interbedded with floodplain ([Qfp](#)) deposits in Pipe Valley area. Subject to extensive sheet wash erosion, deposition, flash flood debris flows, and arroyo erosion. Commonly interbedded with local stream-channel alluvium ([Qs](#)) and sand sheet ([Qes](#)) or sand dune ([Qd](#)) deposits. Contacts with other alluvial deposits are arbitrary and approximate. Thickness, 3 to 20 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Qtr - Talus and rock fall deposits (Holocene)

Include silt, sand, and large to small broken rocks and boulders that form talus debris slopes in steep-walled canyons and lower part of Vermilion Cliffs. Some boulders of Navajo Sandstone or sandstone of the Shinarump Member of the Chinle Formation are as large as vehicles and up to house size near landslide debris ([Ql](#)) deposits below Vermilion Cliffs. Arbitrary and gradational contact between landslide debris ([Ql](#)) deposits, talus and rock fall debris ([Qtr](#)), young, intermediate, and old alluvial fan ([Qa1](#), [Qa2](#), [Qa3](#)) deposits as determined by aerial photo interpretation. Unit grades downslope into young, intermediate, or old alluvial fan ([Qa1](#), [Qa2](#), [Qa3](#)) deposits. Thickness, 5 to 45 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Qg1 - Young alluvial terrace-gravel deposits (Holocene)

Red, white, and gray interbedded fine- to coarse-grained sand and thinly laminated silt; partly consolidated by gypsum and calcite cement. Include interbedded thin beds of gray or red mud and clay and some interbedded lenses of gravel composed of gray subangular chert fragments above outcrops of the Chinle Formation. Include gray-blue subrounded limestone pebbles, and red, yellow, black, or white, well-rounded quartzite pebbles below outcrops of the Shinarump Member of the Chinle Formation. Deposits are inset against intermediate alluvial terrace-gravel ([Qg2](#)) deposits and young and intermediate alluvial fan ([Qa1](#), [Qa2](#)) deposits. Subject to erosion by flash floods or overbank floodplain ([Qfp](#)) sediment accumulation in lower reaches of drainages. Moderately vegetated by sagebrush, grass, cactus, tamarisk trees, willow trees, juniper trees, and some pinion pine trees in canyons eroded into Vermilion Cliffs. Terraces are generally 4 to 10 ft above stream-channel ([Qs](#)) deposits and as much as 40 ft above stream channels in lower reaches of Bulrush Wash and Bitter Seeps Wash. Unit cut by modern arroyos as much as 30 ft deep in Moccasin Canyon and in other unnamed canyons eroded into Vermilion Cliffs. Thickness, 4 to 50 ft or more. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Qa1 - Young alluvial fan deposits (Holocene)

Light-red, gray, and brown silt, fine- to coarse-grained interbedded sand and gravel; partly consolidated by gypsum, calcite, and clay. Contain light-red to brown silt, red and white chert fragments and small red and white sandstone pebbles locally derived from outcrops of the Kayenta Formation and Navajo Sandstone below the Vermilion Cliffs. Locally include boulders of the Shinarump Member of the Chinle Formation as much as 6 ft in diameter near outcrops of the Shinarump below Yellowstone Mesa and Bitter Seeps Wash areas. Clay content greatest near outcrops of Petrified Forest Member of the Chinle Formation in Sandy Canyon Wash, and Pipe Valley

areas. Include numerous black, brown, yellow, red, and gray, very well rounded quartzite and chert pebbles 0.5 to 2 inches in diameter and rare, rounded, gray-white petrified wood fragments derived from Shinarump Member of the Chinle Formation. Locally covered by thin sand sheet ([Qes](#)) and mixed eolian and fluvial ([Qae](#)) or sand dune ([Qd](#)) deposits at distal ends of alluvial fan deposits. Commonly overlapped by or intertongue with stream ([Qs](#)) deposits. Subject to extensive sheet wash erosion or sediment accumulation during heavy storms. Support moderate growths of grass, sagebrush, and various small high-desert shrubs. All deposits below Vermilion Cliffs are composed of sediment derived locally from Triassic and Jurassic sedimentary strata. Thickness, 5 to 40 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Qg2 - Intermediate alluvial terrace-gravel deposits (Holocene and Pleistocene)

Gray, light-red to brown, thin- to massive-bedded, interbedded clay, silt, and fine-to coarse-grained sand similar to young alluvial terrace-gravel ([Qg1](#)) deposits; partly consolidated by clay and gypsum. Unit intertongues with young and intermediate alluvial fan ([Qa1](#), [Qa2](#)) deposits along Bulrush Wash. Map contact is arbitrary between alluvial units. Deposit forms terraces generally 8 to 20 ft above local streambeds in upper reaches of drainages near Vermilion Cliffs and as much as 60 ft above stream channels in lower Bulrush Wash and Bitter Seeps Wash. Intertongue with young and intermediate alluvial fan ([Qa1](#), [Qa2](#)) deposits in upper Pipe Valley Wash, Two-mile Wash, and Sandy Canyon Wash. Arbitrary and gradational contact with young and intermediate alluvial fan deposits. Support moderate growth of grass, cactus, black brush, and sparse sagebrush. Thickness, 8 to 30 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Qa2 - Intermediate alluvial fan deposits (Holocene and Pleistocene)

Similar to young alluvial fan ([Qa1](#)) deposits; partly consolidated by calcite, clay, and gypsum cement below stratigraphic level of the Chinle Formation; mostly unconsolidated above Chinle Formation. Commonly overlapped by young alluvial fan ([Qa1](#)) and stream-channel ([Qs](#)) deposits. Intertongue with intermediate alluvial terrace-gravel ([Qg2](#)) deposits near distal ends of fans. Intertongue with landslide ([Ql](#)) deposits and talus and rock fall ([Qtr](#)) deposits at upper reaches of alluvial fans below Vermilion Cliffs where unit is heavily dissected by erosion. Support moderate growths of sagebrush, cactus, and grass. Thickness, 6 to 45 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Ql - Landslide debris deposits (Holocene and Pleistocene)

Unconsolidated masses of unsorted rock debris typically along lower slopes of Vermilion Cliffs. Include detached blocks of strata that have rotated backward and slid downslope as loose incoherent masses of broken rock and deformed strata, often surrounded by talus and rock fall ([Qtr](#)) debris. Often covered in part by sand sheet ([Qes](#)) and sand dune ([Qd](#)) deposits. Individual landslides may become unstable during wet conditions and creep downslope where unit overlies claystone or siltstone bedrock of Petrified Forest Member of the Chinle Formation or lower part of the Kayenta Formation. Support sparse growth of sagebrush, cactus, grass, juniper trees, and pinion trees. Thickness, 25 to 200 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Qg3 - Old alluvial terrace-gravel deposits (Pleistocene)

Gray and light-brown to light-red clay, silt, and sand similar to young and intermediate alluvial terrace-gravel ([Qg1](#), [Qg2](#)) deposits. Locally contain 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. Unit preserved as scattered deposits along lower reaches of Bulrush Wash and Bitter Seeps Wash, southeast corner of map area. Form terraces about 30 to 120 ft above stream ([Qs](#)) deposits. Unit often covered by thin sand sheet deposits too thin to show at map scale. Support sparse growth of sagebrush, black brush, cactus, and grass. Thickness, 10 to 20 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Qa3 - Old alluvial fan deposits (Pleistocene)

Similar to young and intermediate alluvial fan ([Qa1](#), [Qa2](#)) deposits; stony surface where not covered by sand dune ([Qd](#)) deposits along base of Vermilion Cliffs in northeast quarter of map area. Contribute material to young and intermediate alluvial fan deposits. Composed mainly of silt, sand, gravel, cobbles, and boulders of sandstone locally derived from the Kayenta Formation or Navajo Sandstone. Intertongue with talus and rock fall ([Qtr](#)) and landslide debris ([Ql](#)) deposits. Adjacent to or overlapped by young and intermediate alluvial fan ([Qa1](#), [Qa2](#)), sand sheet ([Qes](#)), and sand dune ([Qd](#)) deposits. Thickness, 10 to 50 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

QTg4 - Oldest alluvial terrace-gravel deposits (Pleistocene and Pliocene)

Lithologically similar to young, intermediate, and old alluvial terrace-gravel ([Qg1](#), [Qg2](#), [Qg3](#)) deposits as isolated deposits in Bulrush Wash about 120 to 180 ft above modern drainage. Deposits are partially preserved in abandoned cutoff meander loops or isolated abandoned point bars in southeast quarter of map area. Thickness, 6 to 20 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Jn - Navajo Sandstone (Lower Jurassic)

White to light-red and yellow-gray, cliff-forming, medium-crossbedded to thickly-crossbedded, well-sorted, fine- to coarse-grained eolian quartz sandstone interbedded with dark-red, coarse-grained sandstone and siltstone in lower part. Age determination by Peterson and Pipiringos (1979) and Biek and others (2000). Lower part is commonly red, upper part commonly white. Includes lenses of interbedded dark purple-gray, thin-bedded, calcareous sandstone beds that formed freshwater deposits within and between coastal sand dunes. High-angle, crossbedded sandstone sets interbedded with low-angle, crossbedded sandstone and thin flat-bedded sandstone sets. Unit commonly covered by thin to thick sand sheet ([Qes](#)), sand dune ([Qd](#)), or mixed eolian and fluvial ([Qae](#)) deposits. Unit is highly fractured by near vertical northeast-, northwest-, and north-south-oriented bedrock joints. Joints that parallel the Moccasin Monocline dip west or southwest as much as 82° and strata of the Navajo Sandstone and Kayenta Formation dip east 8° at Moccasin Canyon and just northwest of Pipe Spring National Monument. Joints are near vertical in upper Moccasin Canyon where strata are nearly horizontal verifying that the joints likely developed prior to development of the Moccasin Monocline. Gradational but sharp contact with underlying Tenney Canyon Tongue of the Kayenta Formation placed at base of Navajo Sandstone cliff at Moquith Mountains and the Kayenta Formation elsewhere. Supports moderate growth of pinion and juniper trees, cliffrose bush; thick growths of sagebrush, various high-mountain shrubs and grasses on Moccasin and Moquith Mountains. Incomplete section due to removal of top part by modern erosion. Unit thickens north of map area to as much as 2,000 ft. Thickness, about 1,500 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Jnl - Navajo Sandstone, Lamb Point Tongue (Lower Jurassic)

Age as described by Biek and others (2000). Type locality is Ed Lamb Point on USGS 7.5' Kaibab quadrangle, Vermilion Cliffs of Moquith Mountains, 8 miles northeast of Moccasin and Kaibab, Arizona (Wilson, 1967). Gray-white to orange-brown, cliff-forming, very fine-grained to fine-grained,

crossbedded quartz sandstone of eolian origin. Top 10 to 15 ft east of Ed Lamb Point locally shows penecontemporaneous deformed beds that are beveled by overlying Tenney Canyon Tongue ([Jkt](#)) of the Kayenta Formation. Forms gradational and sharp contact with underlying Kayenta Formation ([Jk](#)) marked at base of white and red sandstone cliff of the Lamb Point Tongue. Forms cliff of white and red cross-bedded Navajo Sandstone within upper part of Kayenta Formation along Vermilion Cliffs from Moquith Mountains east to Kanab, Utah. Unit is 400 ft thick near Kanab, Utah, thins south and west to 140 ft thick at Moquith Mountains; is mostly a red sandstone cliff about 100 ft thick near Point Spring of Vermilion Cliffs 2 mi north of Moccasin and Kaibab, Arizona. Unit forms an elongated 1-mi-wide tongue of sand that extends southwest from Ed Lamb Point to Moccasin Mountains 2 mi north of Kaibab, Arizona and pinches out as a red sandstone ledge in Vermilion Cliffs 1 mi west of Pipe Spring National Monument. Thickness, 0 to 140 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Jk - Kayenta Formation (Lower Jurassic)

Dark-red and light red-brown, slope-forming calcareous mudstone, siltstone, and sandstone. Unit deposited in river floodplains, river channels, playas, and shallow lake environments (Blakey, 1994; Peterson, 1994). Age of unit determined by Peterson and Pipiringoes (1979) and Biek and others (2000). Unit often covered by landslide debris ([Ql](#)) and talus and rockfall ([Qtr](#)) deposits along lower part of Vermilion Cliffs. Erosion of soft sediments of the Kayenta Formation undercuts the resistant overlying Navajo Sandstone causing large sections of Navajo and upper Kayenta units to fail as landslide blocks along Vermilion Cliffs, especially where local joints parallel Vermilion Cliffs. Thickness increases from 270 ft at Ed Lamb Point to nearly 400 ft at Potter Canyon at the expense and loss of the Lambs Point Tongue of the Navajo Sandstone southwest of Moccasin Mountain. Thickness, 270 to 400 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Jkt - Kayenta Formation, Tenney Canyon Tongue (Lower Jurassic)

Age as described by Biek and others (2000). Dark-red to light red-brown, slope-forming, very fine-grained, thin-bedded to laminated, fluvial siltstone and sandstone. Includes dark-red sandstone lenses that form ledges in upper part. Gradational southwesterly facies change from fine-grained, ledge- and slope- forming sequence to alternating slope-forming, fine- to coarse-grained, mudstone, siltstone, and sandstone sequence. Unit intertongues laterally with underlying Lamb Point Tongue ([Jnl](#)) of the Navajo Sandstone. Forms sharp local horizontal contact at top of Lamb Point Tongue cliff marked by color contrast of dark-red siltstone and sandstone of Tenney Canyon Tongue to white and light-red sandstone of Lamb Point Tongue at Moquith (Moki) Mountain area. Unit thickens from 120 ft at Kanab, Utah, to 220 ft at Ed Lamb Point, Moquith Mountains 8 miles northeast of Kaibab and Moccasin, Arizona. Tenney Canyon Tongue becomes upper part of Kayenta Formation where Lamb Point Tongue of Navajo Sandstone pinches out west and south of Moquith Mountains. Thickness at Moquith Mountain area, 220 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Moenave Formation

Includes, in descending order, the Springdale Sandstone Member, Whitmore Point Member, and Dinosaur Canyon Member as defined by Averitt and others (1955); Stewart and others (1972); and Sargent and Philpott (1987). Age determination after Peterson and Pipiringos (1979) and Biek and others (2000). Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Jms - Moenave Formation, Springdale Sandstone Member (Lower Jurassic)

Light-red to red-brown, cliff-forming, thin- to thick-bedded sandstone and lenses of conglomerate. Includes low-angle trough crossbedded sets of fluvial sandstone that contain dark red mudstone and siltstone rip-up clasts and poorly preserved petrified and carbonized fossil plant remains within crossbedded sets (Peterson and Pipiringos, 1979; Biek and others, 2000). Crossbeds are separated by thin-bedded to laminated dark red siltstone and mudstone beds that locally contain mudstone pellets (Wilson, 1967). Gradational contact with underlying Whitmore Point Member. Unit deposited by northeast to southwest flowing streams based on crossbedding studies by Wilson (1967). Thickens north and east of map area to about 200 ft at Kanab, Utah, thins southward and intertongues with lower part of the Kayenta Formation. Thickness, 120 to 170 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Jmw - Moenave Formation, Whitmore Point Member (Lower Jurassic)

Type section is near Potter Canyon at southwest point of Moccasin Mountains (elev. 6,603 ft at Radio Towers, left end of cross section B-B'). Named for Whitmore Point by Wilson (1967) 3.5 mi west of Pipe Spring National Monument, but the name Whitmore Point is not on the current USGS 7.5' Moccasin quadrangle. Composed of red-brown sandstone and siltstone interbedded with red-purple to green-gray and blue mudstone and claystone and thin gray dolomitic limestone. Limestone contains small red-brown chert nodules and poorly preserved fossil algal structures and fish scales and bones near Zion National Park north of map area (Biek and others, 2000). Gradational contact with underlying Dinosaur Canyon Member ([Jmd](#)) marked by distinct color contrast of blue-green, green, and yellow mudstone and siltstone of Whitmore Point Member to red-brown siltstone and sandstone of underlying Dinosaur Canyon Member. Thickness, 60 to 80 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Jmd - Moenave Formation, Dinosaur Canyon Member (Lower Jurassic)

Red-brown, slope and ledge-forming, thin-bedded, very fine-grained sandstone and silty sandstone. Unconformable contact with underlying undivided Owl Rock and Petrified Forest Members of the Chinle Formation. Unit gradually thickens west to east and is about 200 ft thick at Kanab, Utah (Wilson, 1967). Thickness, 120 to 200 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Chinle Formation

Includes, in descending order, the Owl Rock Member, Petrified Forest Member, and Shinarump Member as used by Stewart and others (1972); Sargent and Philpott (1987); Biek and others (2000). Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

TRcp - Chinle Formation, Owl Rock and Petrified Forest Members, undivided (Upper Triassic)

The Owl Rock Member of the Chinle Formation, (not mapped separately) is present at the south end of the Moquith Mountains, northeast corner of the map area and gradually thins to the west and southwest and overlies the Petrified Forest Member. The Owl Rock is composed of light-red and white, coarse-grained sandstone, gray, fine-grained sandstone and siltstone interbedded with thin-bedded (5 in to 2 ft) gray-white siliceous limestone beds. Limestone contains red and white chert nodules. The Owl Rock is 40 ft thick at Kanab, Utah, and thins to less than 30 ft at Ed Lamb Point and grades into the upper part of the Petrified Forest Member throughout the map area. The Petrified Forest Member is composed of gray, light-purple, blue, light- to dark-red, slope-forming claystone, siltstone, and white, coarse-grained sandstone. Weathers to frothy popcorn surface. Includes petrified

wood and calcite nodules at the Blue Knolls area. Unit is mostly covered by sand sheet ([Qes](#)) and sand dune ([Qd](#)) and mixed fluvial and eolian ([Qae](#)) deposits, and young, intermediate, and old alluvial fan ([Qa1](#), [Qa2](#), [Qa3](#)) deposits. Contact with underlying Shinarump Member is gradational in the vertical and lateral extent because multicolored mudstone and siltstone intertongue with white gritty sandstone and conglomerate of the Shinarump Member. Thickness, 600 to 700 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

TRcs - Chinle Formation, Shinarump Member (Upper Triassic)

White to yellow-brown, cliff-forming, thin- to thick-bedded, coarse-grained, low-angle crossbedded sandstone, gravel, and conglomeratic sandstone. Includes numerous small channel lenses and pockets of small pebble conglomerate composed of well rounded to subrounded, multicolored quartz, quartzite, and black chert pebbles in gravely sandstone matrix. Black chert pebbles are the dominant pebble. Pebbles average 1 to 2 inches in diameter and include some well-rounded quartzite cobbles as much as 10 inches in diameter and numerous petrified wood fragments and segments of petrified logs. Black pebbles eroded from the Yellowstone Mesa area form a desert pavement of lag gravel on all alluvial fan surfaces around Yellowstone Mesa, southwest quarter of map area. Unit is the common source for multicolored quartz, quartzite, and chert pebbles in all surficial units below outcrops of the Shinarump Member of the Chinle Formation. Weathered sand from the Shinarump Member is a source for local sand sheet ([Qes](#)) and sand dune ([Qd](#)) deposits that overlie the Petrified Forest Member east of the Vermilion Cliffs. Unit overlies and fills broad erosion channels that are as deep as 30 ft and ½ to 1 mi wide eroded into underlying upper red member of the Moenkopi Formation. Thickness, 20 to 125 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Moenkopi Formation

Includes, in descending order, upper red member, Shnabkaib Member, middle red member, Virgin Limestone Member, lower red member and Timpoweap Member, undivided, as used by Stewart and others (1972). (Timpoweap Member is redefined for this map area due to facies changes of the Timpoweap Member from that defined by Stewart and others [1972]). Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

TRmu - Moenkopi Formation, upper red member (Middle(?) and Lower Triassic)

Light-red and dark-red, slope- and ledge-forming sequence of siltstone and sandstone. Forms small cliffs in upper part. Gradational contact with underlying Shnabkaib Member placed arbitrarily at top of highest thick white siltstone and dolomite bed of Shnabkaib Member. Thickness, 160 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

TRms - Moenkopi Formation, Shnabkaib Member (Lower Triassic)

White to light-gray, laminated to thinly bedded, slope-forming, aphanitic dolomite interbedded with light-gray, calcareous silty gypsum. Includes some thin light red mudstone, siltstone, and sandstone beds in lower and upper part. Gradational contact with underlying middle red member placed at lowest thick white or light-gray calcareous siltstone and dolomite bed of the Shnabkaib Member. Unit thickens northwest of map area, thins southeast. Thickness, 90 to 110 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

TRmm - Moenkopi Formation, middle red member (Lower Triassic)

Red-brown, thin-bedded to laminated, slope-forming gypsiferous siltstone and sandstone. Includes thin veinlets and stringers of gypsum deposited in fractures and cracks throughout unit. Includes

minor beds of white laminated dolomite, green siltstone, and gray-green to red gypsiferous mudstone. Mudcracks and ripple marks common throughout. Gradational lower contact with Virgin Limestone Member placed at top of highest gray limestone bed of Virgin Limestone Member. Thickness, 280 to 300 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

TRmv - Moenkopi Formation, Virgin Limestone Member (Lower Triassic)

Includes two light-gray, thin-bedded to laminated, ledge-forming limestone beds (1 to 3 ft thick), separated by pale-yellow, light-red, and bluish-gray, thin-bedded to massive, slope-forming gypsiferous siltstone that makes up the bulk of the unit. Lowest limestone bed contains star-shaped crinoid plates and poorly preserved Composita brachiopods in upper part 18 mi east of map area; locally, upper limestone bed contains fossil algae. Erosional unconformity separates lower gray limestone from underlying dark red siltstone and sandstone of lower red member of the Moenkopi Formation with erosional relief as much as 4 ft. Lower limestone bed thickens and thins as shallow channel-fill deposit. Forms small mesas near Bitter Seeps Wash and Pipe Valley Wash. Thickness, 120 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

TRml - Moenkopi Formation, lower red member and Timpoweap Member, undivided (Lower Triassic)

Dark-red, slope-forming, thin-bedded, fine-grained, gypsiferous, sandy siltstone, sandstone, and pale-yellow to gray laminated silty gypsum. Gypsum, siltstone, and sandstone in lower part are derived from erosion of Harrisburg Member of the Kaibab Formation. Includes a prominent ledge-forming red-gray to light purple-red, coarse-grained, low-angle crossbedded calcareous sandstone marker bed in lower part 3 to 7 ft thick that often forms resistant sandstone surface of Kanab Plateau near Bulrush Wash and Bitter Seeps Wash. Marker bed includes raindrop impressions and rare carbonaceous plant fossils 18 mi east of map area (Billingsley and others, 2002). Has unconformable contact with underlying gray limestone and red sandstone and siltstone of Harrisburg Member of the Kaibab Formation at southeast edge of map area. Thickness, 120 to 180 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Kaibab Formation

Includes, in descending order, Harrisburg and Fossil Mountain Members as defined by Sorauf and Billingsley. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Pkh - Kaibab Formation, Harrisburg Member (Lower Permian)

Red and gray, slope-forming, interbedded gypsiferous siltstone, sandstone, gypsum, and gray, cliff-forming, thin-bedded limestone. Yellow-gray to light-red alternating slope and ledge-forming calcareous sandstone and sandy limestone in upper part; contains calcite and gypsum cement. Upper part includes thin beds of low-angle crossbedded, calcareous sandstone, conglomerate, and minor siltstone that form small ledges in Burnt Canyon Point area, southeast corner of map area. Limestone beds are as much as 14 ft thick consisting of a gray, thin-bedded, cherty limestone that weathers dark brown or black and a light-gray, thin-bedded, sandy limestone. Limestone beds thicken and thin laterally and form small cliffs in the Bulrush and Sandy Canyon Wash areas. Dissolution of gypsum in lower part has locally distorted some limestone beds causing them to slump or bend into local drainages. Contact with underlying Fossil Mountain Member is gradational and marked at top of cherty limestone bed of the Fossil Mountain Member of the Kaibab Formation. Thickness, 160 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Pkf - Kaibab Formation, Fossil Mountain Member (Lower Permian)

Light-gray, fine- to medium-grained, thin-bedded, fossiliferous, cliff-forming, sandy, cherty limestone. Unit characterized by thin bedded, white chert beds and nodules in sandy cliff-forming limestone. Contact with underlying Woods Ranch Member of the Toroweap Formation is not exposed in map area but is exposed 3 mi southeast of map area in Kanab Canyon where contact is an unconformity caused by a combination of dissolution of gypsum and channel erosion with relief as much as 6 to 15 ft. Thickness, 250 ft. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Toroweap Formation

Includes, in descending order, Woods Ranch, Brady Canyon, and Seligman Members, as defined by Sorauf and Billingsley (1991) and described by Billingsley and Priest (2003) adjacent to southwest corner of map area. Units are exposed in Kanab Canyon just south of the map area. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Ptw - Toroweap Formation, Woods Ranch Member (Lower Permian)

Gray, slope-forming gypsiferous siltstone and pale-red silty sandstone interbedded with white laminated gypsum. Beds are locally distorted because of the dissolution of gypsum. Lower contact gradational. Thickness varies from 180 to 265 ft because of the dissolution of gypsum. Unit shown in cross section only. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Ptb - Toroweap Formation, Brady Canyon Member (Lower Permian)

Gray, cliff-forming, medium-bedded, fine- to coarse-grained, fetid, fossiliferous limestone; weathers dark gray. Includes thin-bedded dolomite in upper and lower parts. Limestone beds average about 1 to 2 ft thick and include chert lenses and nodules. Lower gradational contact with underlying Seligman Member of the Toroweap Formation. Contact commonly covered by minor slump or talus debris. Thickness, 230 ft. Unit shown in cross section only. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

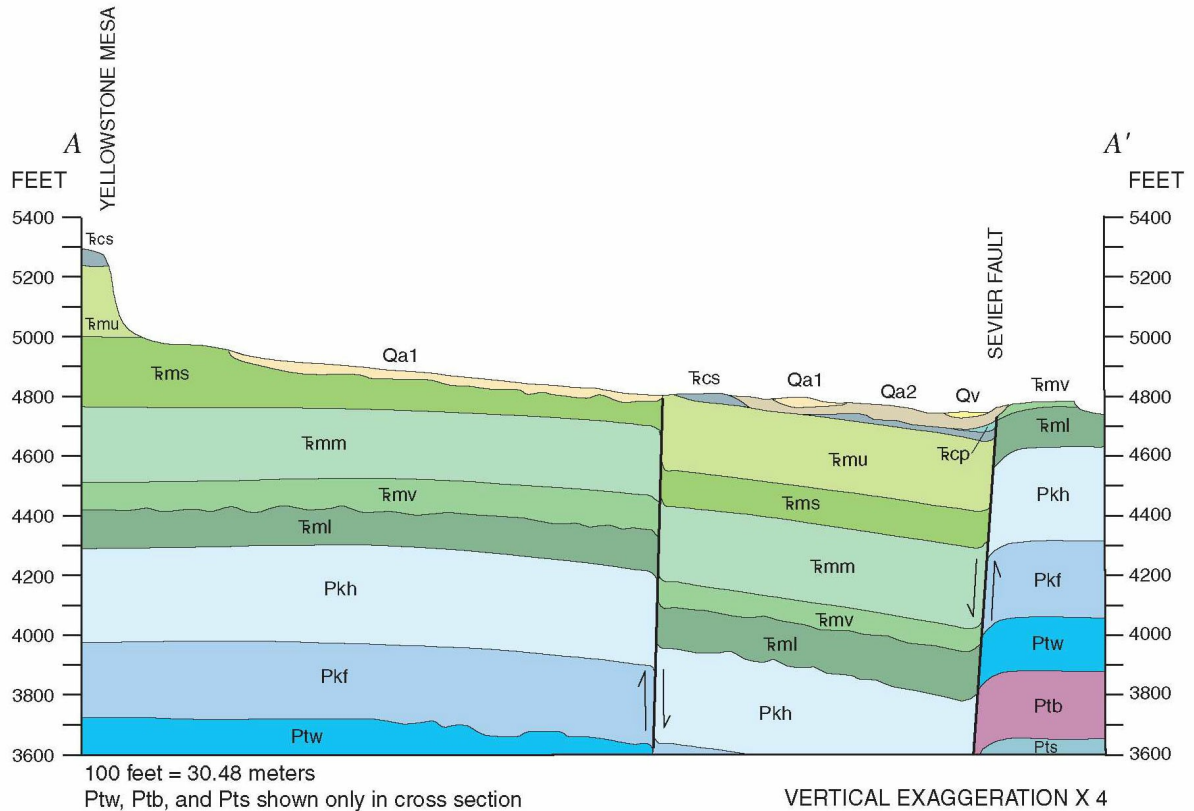
Pts - Toroweap Formation, Seligman Member (Lower Permian)

Gray, thin-bedded, slope-forming dolomite and gypsiferous sandstone. Middle part includes gray to red, thinly interbedded siltstone, sandstone, and gypsum; includes interbedded, crossbedded sandstone of the Coconino Sandstone in the middle part. Lower part includes brown, purple, and yellow, fine- to medium-grained, thin-bedded, low- to high-angle crossbedded and planar-bedded sandstone that is mostly covered by talus debris. Contact with underlying Hermit Formation is unconformable with erosional relief as much as 3 ft; contact mostly covered by talus and alluvial deposits. Thickness, 170 ft. Unit shown in cross section only. Description from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Geologic Cross Sections

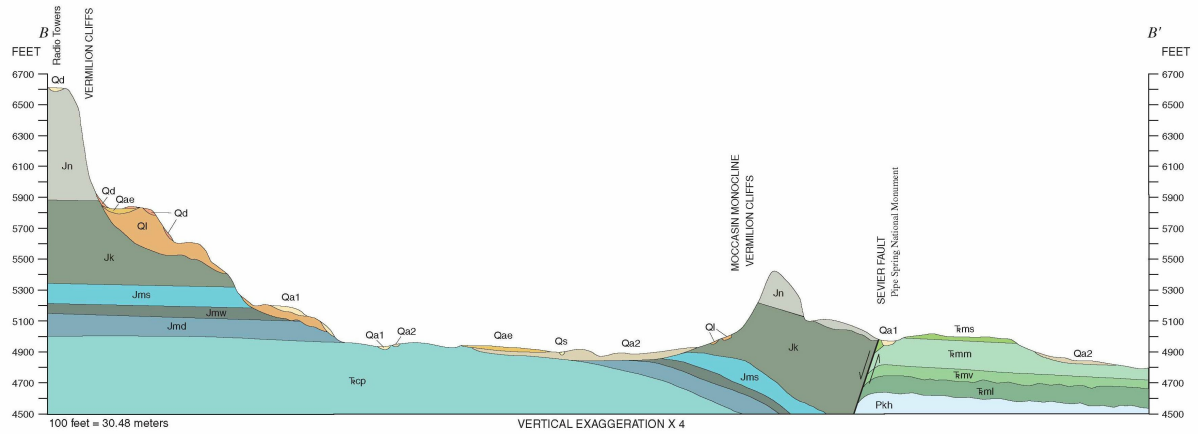
The geologic cross sections present in the GRI digital geologic-GIS data produced for Pipe Spring National Monument, Arizona (PISP) are presented below. Cross section graphics were scanned at a high resolution and can be viewed in more detail by zooming in (if viewing the digital format of this document).

Cross Section A-A'



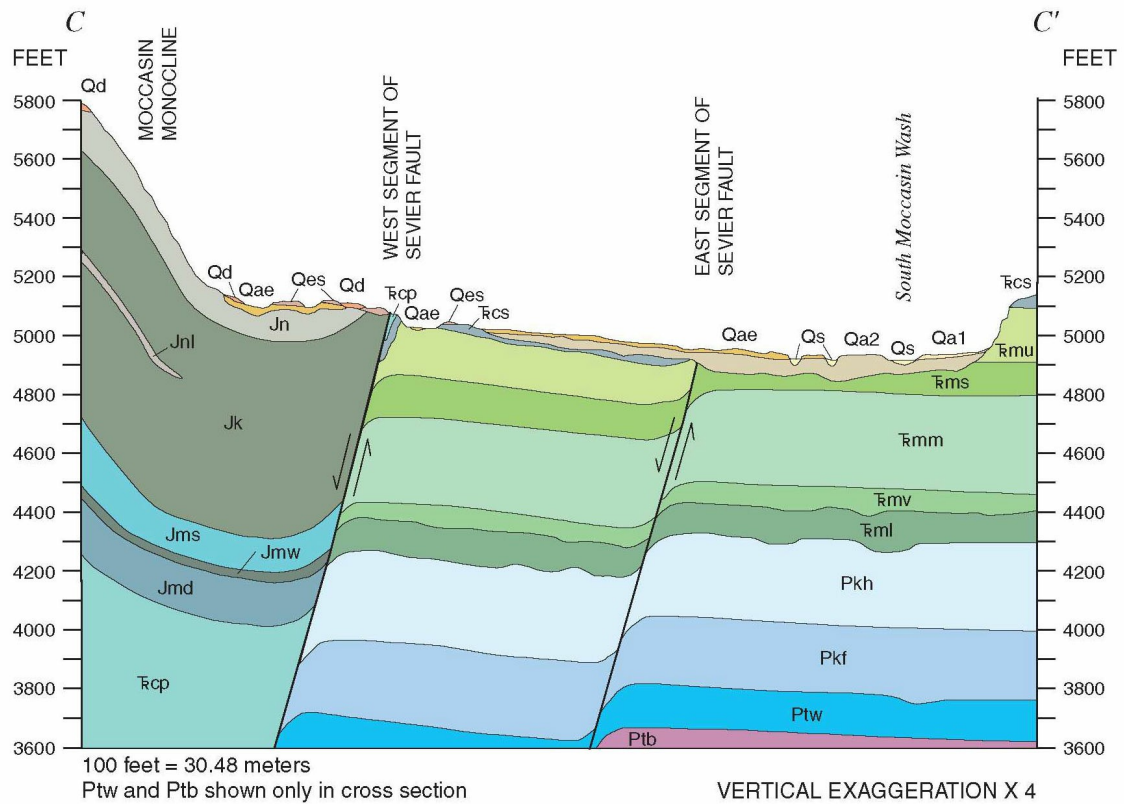
Graphic from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Cross Section B-B'



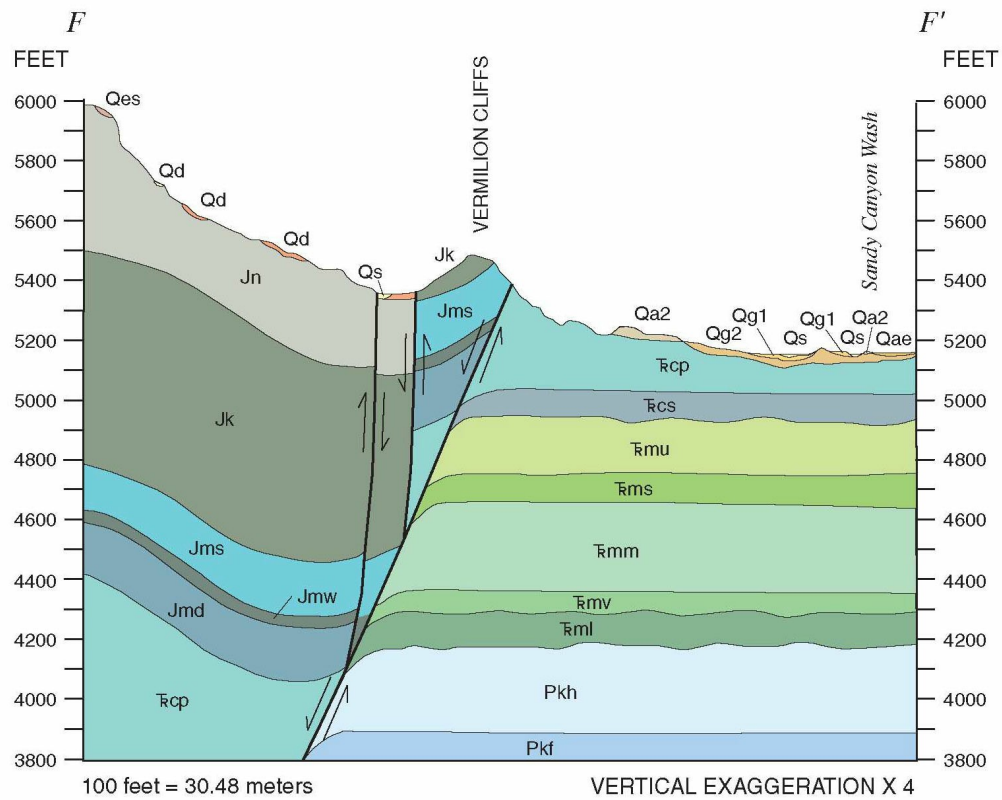
Graphic from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Cross Section C-C'



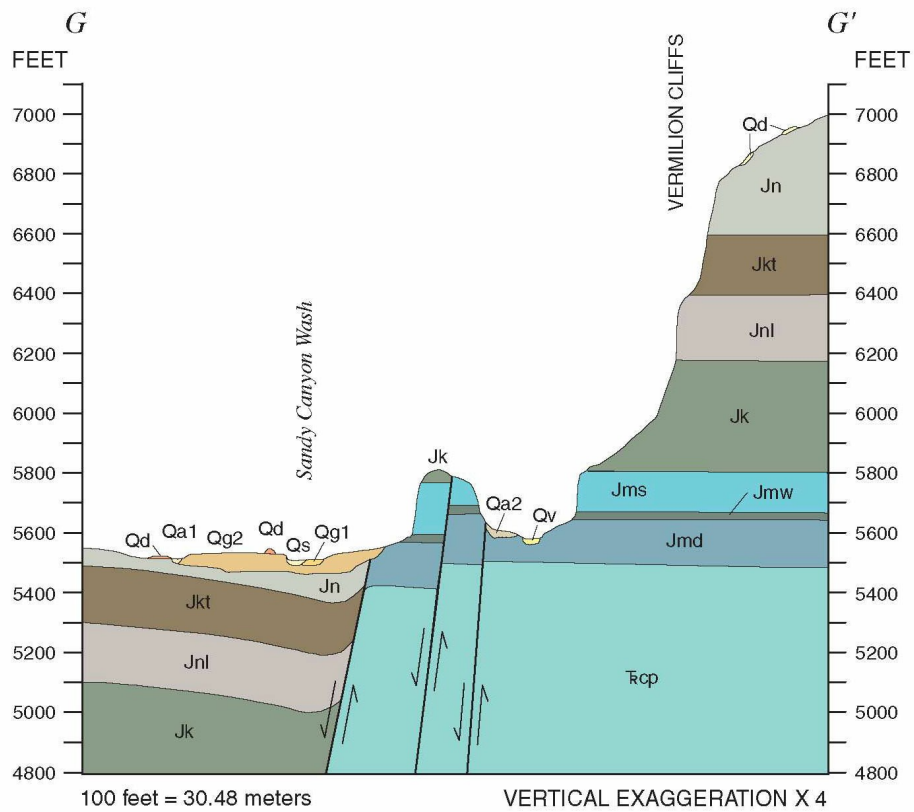
Graphic from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Cross Section F-F'



Graphic from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Cross Section G-G'



Graphic from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Ancillary Source Map Information

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

Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation

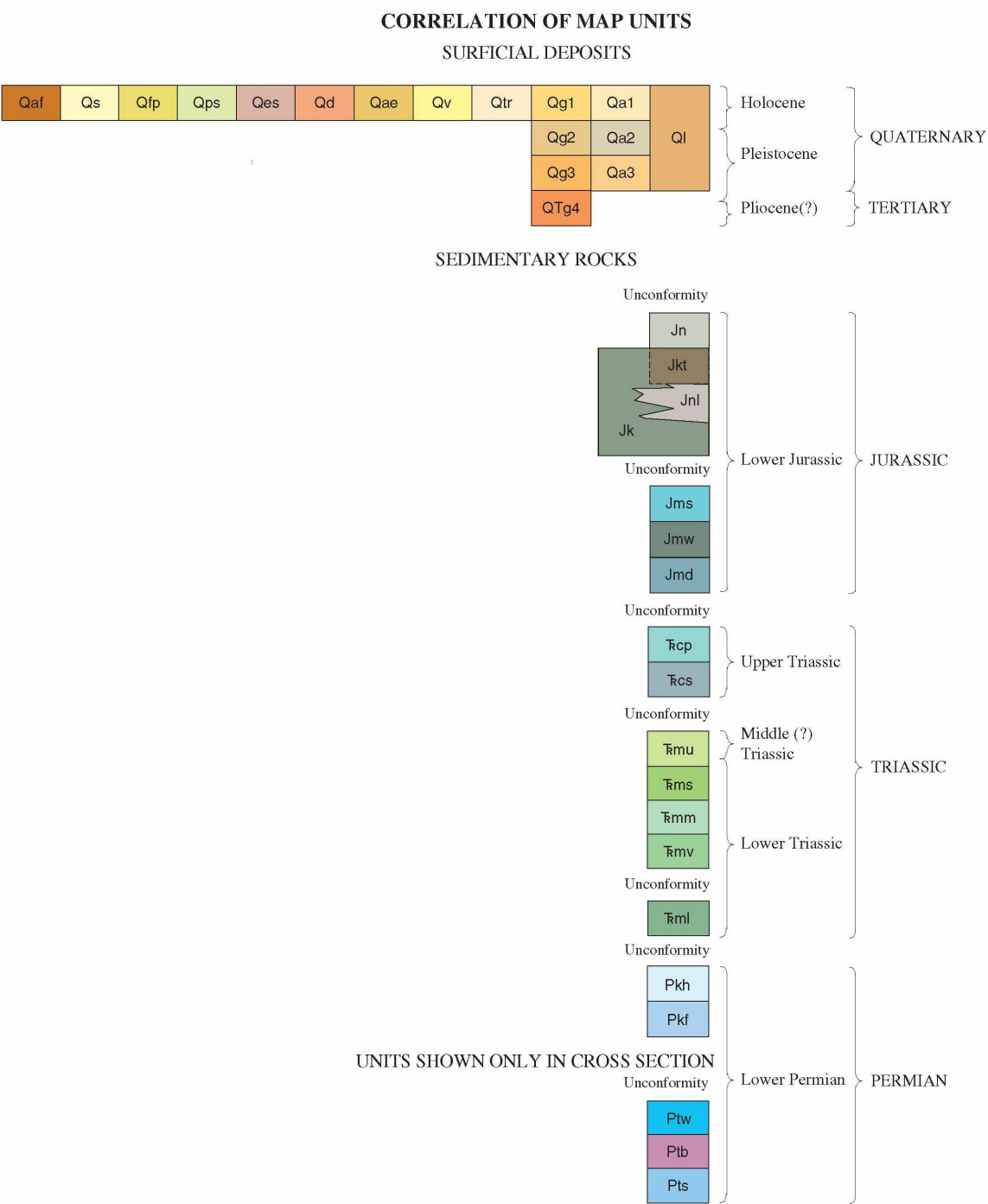
The formal citation for this source.

Billingsley, G.H., Priest, S.S., and Felger, T.J., 2005, Geologic Map of Pipe Spring National Monument and the Western Kaibab-Paiute Indian Reservation, Mohave County, Arizona: U.S. Geological Survey, SIM-2863, scale 1:100,000 (*GRI Source Map ID 5407*).

The above source map including its map pamphlet can be found online at the following U.S. Geological Survey publications page: <https://pubs.usgs.gov/sim/2004/2863/>. The source map plate is also available from the National Geologic Map Database (NGMDB) Catalog site at: https://ngmdb.usgs.gov/Prodesc/proddesc_70025.htm

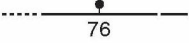
Prominent graphics and text associated with this source.

Correlation of Map Units



Graphic from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

Legend

EXPLANATION	
	Contact —Dashed where Jkt becomes Jk; approximate contact for alluvial units only
	Fault —Dashed where inferred or approximately located; dotted where concealed; bar and ball on downthrown side. Faults shown as bounding alluvium do not offset alluvium. Number is estimated separation displacement in feet
	Folds —Showing trace of axial surface and direction of plunge; dotted where concealed
	Syncline
	Monocline
Strike and dip of beds	
	Inclined —Measured in the field
	Implied —Interpreted from aerial photographs; dip amount not determined
	Strike of vertical and subvertical joints
	Collapse structure —Circular collapse structures characterized by strata dipping inward toward central point. On Kaibab Formation surface (Pkh), may reflect collapse of deep-seated breccia pipe that originated in Redwall Limestone
	Kaibab-Paiute Indian Reservation Boundary

Graphic from source map: [Pipe Spring National Monument and Western Kaibab-Paiute Indian Reservation](#)

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 GRI source map, and is intended to accompany the digital geologic-GIS map and other digital data for Pipe Spring National Monument, Arizona (PISP) developed by Stephanie O'Meara (see the [GRI Digital Map and Source Map Citation](#) section of this document for all sources used by the GRI in the completion of this document and related GRI digital geologic-GIS map). The initial GRI digital geologic-GIS version of this dataset was produced by Jim Chappell (Colorado State University) and Stephanie O'Meara.

GRI finalization by Stephanie O'Meara.

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