U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

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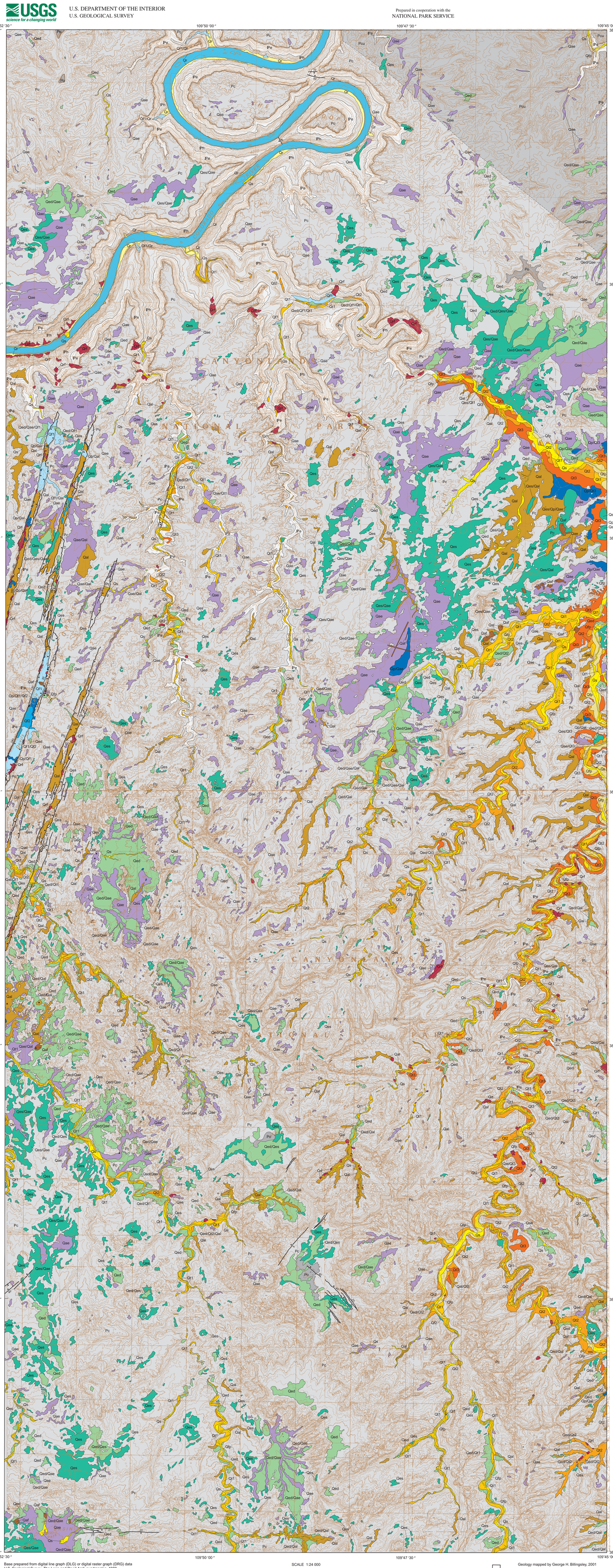
MISCELLANEOUS FIELD STUDIES MAP MF–2411



Base prepared from digital line graph (DLG) or digital raster graph (DRG) data U.S. Geological Survey, The Loop and Druid Arch quadrangles, 1988

Universal Transverse Mercator projection
1927 North American Datum
Clarke 1866 Ellipsoid, Zone 12

SCALE 1:24 000

1 0.5 0 1 MILE

1 0.5 0 1 KILOMETER

CONTOUR INTERVAL 40 FEET

UTAH
MAP LOCATION

Geology mapped by George H. Billingsley, 2001

Digital database by George H. Billingsley, Debra L. Block, and Tracey J. Felger

Edited by Theresa Iki

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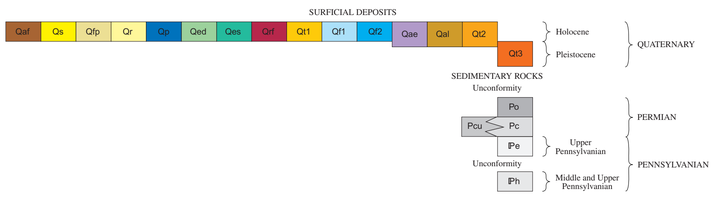
Surficial Geologic Map of The Loop and Druid Arch Quadrangles, Canyonlands National Park, Utah

By

George H. Billingsley, Debra L. Block, and Tracey J. Felger

2002

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

[Units shown with slashes indicate thin deposits of the first unit over the second and sometimes third unit. Not all composite units are shown. Some unit exposures on the plotted map are too small to distinguish the color for unit identification. These units are labeled where possible, and unlabled units are attributed in the database]

SURFICIAL DEPOSITS

Surficial deposits are differentiated from one another chiefly on the basis of difference in morphologic character and physiographic position illustrated on aerial photographs and field observations. Older alluvial and aeolian deposits generally exhibit extensive erosion, whereas younger deposits are actively accumulating material or are lightly eroded as observed on 1995 color aerial photographs. Salt is a common constituent in all alluvial deposits and, to a lesser degree, in aeolian deposits

Qaf — **Artificial fill and quarries (Holocene)**—Alluvium and (or) bedrock material removed from barrow-pits and trenches to build stock tanks, drainage diversion dams, roads, and other construction projects other than modern highways. No distinction on map between cut or fill excavations. Areas generally disturbed by construction projects or quarrying

Qs — **Stream-channel alluvium (Holocene)**—Interlensing silt, sand, gravel, and pebbles; unconsolidated and poorly sorted. Locally overlaps or erodes into young and intermediate alluvial terrace deposits (Qt1, Qt2) and floodplain (Qfp) deposits. Generally inset against young, intermediate, and old alluvial terrace (Qt1, Qt2, and Qt3) deposits. Gradational contact with floodplain (Qfp) deposits. Stream channels subject to intermittent high-energy flows and flash floods producing sediment accumulation on floodplains or lateral erosion into young, intermediate, and old terrace deposits. Little or no vegetation growing in stream channels except for local tamarisk, willow, juniper, or oak trees due to close proximity to bedrock where ground water is shallow. Thickness, 3 to 6 ft

Qfp — **Floodplain deposits (Holocene)**—Light-gray or tan silt, fine- to coarse-grained sand, and interbedded pebble gravel lenses; unconsolidated. Gravel locally contains red, subrounded to subangular chert fragments and gray-blue, rounded limestone pebbles 0.25 to 0.75 in. in diameter. Seasonal floods may produce fresh deposits that generally accumulate on the inside bends (point bars) of drainages and locally erode into or overlie young alluvial terrace (Qt1) deposits. Subject to stream-channel erosion or overbank flooding. Gradational and arbitrary contacts between stream-channel (Qs) and floodplain (Qfp) deposits both laterally and vertically. Support thick growths of tamarisk trees and other water-dependent plants where stream bedrock is very shallow, usually less than 10 ft in depth. Dense growths of tamarisk often help to trap and accumulate sediment to form floodplain deposits. Deposits are generally 3 to 6 ft above stream-channel deposits and often grade laterally into stream-channel (Qs) deposits where stream is not eroding. Thickness, 3 to 10 ft

Qr — **Colorado River terrace deposits (Holocene)**—Gray and brown clay, silt, and sand; unconsolidated. Form terrace deposits along banks of the Colorado River consisting of thin-bedded to laminated beds of silt and fine-grained sand and interbedded coarse-grained lenses of small pebble gravel. Include interbedded thin beds of gray and red mud and clay. Support heavy vegetation cover of tamarisk trees and sagebrush. Thickness, 15 to 40 ft

Qp — **Ponded deposits (Holocene)**—Light-gray to white clay, silt, and fine-grained sand. Locally include angular red chert fragments and small, gray-blue, rounded limestone pebbles. Sediments accumulate in temporary ponded areas on intermediate and old alluvial terrace (Qt2 and Qt3) deposits along Salt Creek due to temporary natural sand dune accumulations or flood overbank sand levee deposits that prevent sediments from reaching Salt Creek for an extended, unknown amount of time. Some deposit areas have been breached by low-gradient outflow drainage due to gradual headward erosion from Salt Creek. Include ponded deposits in Chesler Park and other areas where widespread sand sheet and dunes accumulate and form temporary internal ponded areas that eventually become subject to erosion. In The Grabens area, ponded deposits either have no external drainage or accumulate in lowland areas where drainage is blocked by young faulting. Desiccation cracks often form on dry, hardpan surface that restricts plant growth. Thickness, 1 to 6 ft

Qed — **Sand dune deposits (Holocene)**—Light-red to white silt and fine- to coarse-grained aeolian sand. Form climbing dunes that ramp upward toward steep or cliff topography and falling dunes on steep, downslope topography. A few minor barchan dunes present, no parabolic dunes observed. Arbitrary and gradational contact between sand-sheet (Qes) and alluvium and sand-sheet (Qae) deposits based on topography, aerial photography, or relative thickness of sand. Dune surfaces are commonly active in large open valley areas that support sparse growths of grass or small shrubs. Unit is highly stabilized by grassy vegetation or by crypto-organic growths in small, nearly enclosed basins or in some reaches of local canyon drainage areas. Thickness, 12 to 30 ft

Qes — **Sand-sheet deposits (Holocene)**—Light-red to white silt and fine- to coarse-grained aeolian sand on flat-topped ridges and mesas derived from the Cedar Mesa Sandstone (Pc). Deposit also accumulates downwind of local surficial (Qs, Qt1, Qt2, Qt3, Qae, Qal, and Qed) deposits. Unit forms widespread sand ramps on southwest-sloping topography. Deposit often leads to sand dune (Qed) accumulations that pile up against steep bedrock topography, which also slows the wind to allow sand sheet or dune accumulation on steep down-slope topography that acts as sand trap areas. Dunes are often stabilized by grassy and small shrub vegetation during wet year conditions. Arbitrary and gradational lateral and vertical contact between sand-sheet (Qes) and sand dune (Qed) deposits based on morphologic interpretation of aerial photos. Only most extensive mappable deposits are shown. Support moderate growths of grass and blackbrush. Thickness, 0.5 to 3 ft, but as much as 9 to 12 ft in large valleys and enclosed basin areas

Qrf — **Rock fall debris (Holocene)**—Sand, small and very large broken boulders that form talus debris slopes in steep-walled canyons and as local rock falls in The Grabens area. Includes individual large, car- and house-size boulders in The Grabens area. Thickness, 1 to 25 ft

Qt1 — **Young alluvial terrace deposits (Holocene)**—Gray to light-reddish-brown clay, silt, and fine- to coarse-grained sand; unconsolidated. Include interbedded lenses of gravel composed of red, subangular chert fragments; small, gray-blue, subrounded limestone pebbles; and red or white, well-rounded sandstone pebbles. Deposits inset against intermediate (Qt2) and old (Qt3) alluvial terrace deposits. Unit subject to flash flooding and local stream erosion. Heavily vegetated by sagebrush; include cottonwood and willow trees. Form terraces 4 to 8 ft above stream-channel alluvium (Qs) deposits. Thickness, 4 to 10 ft or more

Qf1 — **Young alluvial fan deposits (Holocene)**—Light-red to brown silt, fine- to coarse-grained interbedded sand and gravel; unconsolidated. Red and white chert fragments and small red and white sandstone pebble clasts common and locally derived from nearby bedrock outcrops. In The Grabens area, commonly overlapped by or intertongue with alluvial (Qal) and ponded (Qp) deposits. Subject to extensive sheet-wash erosion or sediment accumulation. Support moderate growth of grass, tall sagebrush, and various small shrub vegetation. Thickness, 5 to 20 ft

Qf2 — **Young intermediate alluvial fan deposits (Holocene)**—Light-red to brown clay, silt, and fine- to coarse-grained sand; unconsolidated. Only in The Grabens area. Similar to young alluvial fan (Qf1) deposits, but subject to sheet wash and arroyo erosion at upper part of fan. Generally 2 to 4 ft higher than young alluvial fan (Qf1) deposits except at distal ends where commonly overlapped by young alluvial fan (Qf1), ponded (Qp), and alluvial (Qal) deposits. Thickness, 10 to 55 ft

Qae — **Alluvium and sand sheet deposits (Holocene and Pleistocene?)**—Gray, light-red, and brown clay, silt, and fine- to coarse-grained sand interbedded with lenses of coarse-grained gravel composed of red angular chert fragments and red subrounded sandstone pebbles. Include sediment accumulated by combinations of alluvial or aeolian processes that result in an interbedded mix of aeolian and alluvial deposits. Deposits subject to sheet-wash erosion and deposition in wet conditions and wind-blown sand deposition in dry conditions. Commonly occupy broad lowland tributary valleys and canyons of Salt Creek and valleys in The Grabens area. Include small isolated deposits where water and wind transported materials have accumulated in local shallow canyon drainages or in large joint depressions in higher slick rock areas. Often overlapped by sand sheet (Qes) or sand dune (Qed) deposits. Support thick to moderate growth of grass, cactus, and local shrubs. Thickness in valley areas, 5 to 35 ft; in slick rock areas, 1 to 4 ft

Qal — **Alluvial deposits (Holocene and Pleistocene?)**—Gray, light-red, and light-brown clay, silt, sand, and interbedded lenses of pebble-size gravel; partly consolidated. Unit intertongues with or is overlapped by intermediate (Qt2) or old alluvial terrace (Qt3) deposits. Common in low-gradient valleys in The Grabens area and within narrow tributary drainages of Salt Creek and other unnamed canyon drainages. Deposit is commonly subject to arroyo erosion as much as 10 ft in depth in narrow tributary canyons caused by headward erosion from larger mainstream drainages such as Salt Creek. Unit is subject to sheet-wash flooding and ponding of silt and mud due to either thickness of vegetation cover or fresh sand accumulations that allow temporary ponding of a few months to a few years. Support moderate to thick growth of sagebrush, grass, cactus, and tall shrubs. Thickness, 10 to 40 ft or more

Qt2 — **Intermediate alluvial terrace deposits (Holocene and Pleistocene?)**—Gray, light-red, and brown clay, silt, and fine- to coarse-grained sand similar to young (Qt1) deposits; partly consolidated. Deposits form terraces generally 8 to 12 ft above local streambeds and often inset against old alluvial terrace (Qt3) deposits, but equivalent to tributary alluvium (Qal) in upper valley reaches of Salt Creek. Gradational and arbitrary contact between alluvial (Qal) deposits where tributary drainages intersect Salt Creek. Support moderate growth of cottonwood trees, rabbit brush, and sagebrush. Thickness, 8 to 14 ft

Qt3 — **Old alluvial terrace deposits (Pleistocene)**—Gray and light-brown clay, silt, and sand similar to young (Qt1) and intermediate (Qt2) alluvial terrace deposits. Locally, include lenses of small pebble gravel and conglomerate composed of white and red, rounded sandstone, blue-gray rounded limestone, and subrounded red chert in coarse-grained gravel matrix. Unit grades or intertongues into local tributary alluvium (Qal) or alluvium and sand-sheet (Qae) deposits along lower reaches of Salt Creek. Form terraces about 15 to 24 feet above stream (Qs) deposits. Scattered and isolated old terrace deposits in upper reaches of Salt Creek and in cutoff meander loops often covered by sand dune (Qed) deposits. Support thick to moderate growths of sagebrush, rabbit brush, cactus, and minor grasses; cactus is most common along Salt Creek. Commonly interbedded with or overlapped by ponded (Qp), alluvium (Qal), and alluvium and sand-sheet (Qae) deposits along lower reaches of Salt Creek. Thickness, 14 to 25 ft

SEDIMENTARY ROCKS

Po — **Organ Rock Member of the Cutler Formation (Permian)**—Dark-red, fine- to coarse-grained, thin-bedded, slope-forming, arkosic sandstone and siltstone. Includes dark-red conglomeratic sandstone lenses that form ledges in upper part. Gradational southwest facies change from coarse-grained, ledge- and slope-forming arkosic sequence to alternating fine-grained, slope-forming sandstone, siltstone, and mudstone sequence. Unit intertongues with underlying Cedar Mesa Sandstone forming a gradational and arbitrary vertical and lateral contact with underlying Cedar Mesa Sandstone marked by a color contrast from dark red Organ Rock Member of the Cutler Formation to white Cedar Mesa Sandstone in southern part of map area, and dark red Organ Rock Member over light red Cedar Mesa Sandstone in northeast part of map area. Contact with overlying Triassic Moenkopi Formation is unconformable just east of the map area, but not present within the map area due to modern erosion. Thickest incomplete section, about 60 ft thick, caps the top of highest unnamed ridge in northeast quarter of map area and forms red caprock, less than 30 ft thick, on small, unnamed mesas in south part of map area

Pcu — **Cutler Formation and Cedar Mesa Sandstone, undifferentiated (Permian)**—Light-red, fine- to coarse-grained, well-sorted, cliff-forming sandstone and interbedded dark-red, coarse-grained, slope-forming gravel, sandstone, and mudstone beds. Includes minor beds of white, fine- to coarse-grained sandstone and blue-gray, thin-bedded, fossiliferous limestone. Dashed line on map represents the median of a two-mile-wide transition zone, which is a regional general facies change from numerous light-red and dark-red fluvial arkosic sandstone and siltstone sediments of the Cutler Formation that intertongue with or grade southwestward into white and light-red, fine-grained, well-sorted, highly crossbedded marine sandstone beds of the Cedar Mesa Sandstone (Huntoon and others, 1982; Baars, 1962, 2000). Light-red sandstone beds of the Cedar Mesa Sandstone thin and pinch out into the Cutler Formation within a few miles northeast of the map area. Unit forms a series of alternating sandstone cliffs and siltstone slopes. Thickness, 800 ft

Pc — **Cedar Mesa Sandstone (Permian)**—Light-red to white, slope- and cliff-forming, medium- to thick-bedded sandstone and siltstone interbedded with dark-red, coarse-grained, arkosic gravel, sandstone, siltstone, and mudstone. Includes thin-bedded, blue-gray limestone beds as channel lenses interbedded within dark-red siltstone and arkosic gravel in lower slope. High-angle, crossbedded sandstone sets accumulated at or near a fluctuating shoreline environment as aeolian coastal dune deposits, and interbedded with low-angle, crossbedded sandstone sets containing rare crinoid ossicles representing near-shore shallow coastal deposits. Lower slope unit is red, thin-bedded siltstone, sandstone, and interbedded blue-gray, thin-bedded limestone and calcareous sandstone. Contact with underlying Elephant Canyon Formation (Pe) is gradational and arbitrary, both laterally and vertically, and placed at the highest continuous cliff-forming limestone bed of the Elephant Canyon Formation. Thickness, as much as 1,500 ft

Pe — **Elephant Canyon Formation (Upper Pennsylvanian)**—Blue-gray, thin- to medium-bedded, cliff- and slope-forming fossiliferous limestone, calcareous sandstone, and interbedded red and gray-red calcareous siltstone and mudstone. Unit generally forms a series of limestone cliffs and sandstone and siltstone slopes. Limestone beds thicken and thin locally and pinch out laterally. Originally indicated as Lower Permian (Wolfcampian) age (Baars, 1962), but more recently established as latest Pennsylvanian (Virgillian) age based on re-examination of fusulinids (Baars, 2000). Unit grades southward into red beds of the Halgaito Formation just south of the map area, and northeast into the arkosic rocks of the Cutler Formation just north of the map area. Unconformable contact with underlying Honaker Trail Formation (Ph) marked by slight angular discordance difficult to see near confluence of Green and Colorado Rivers just west of the map area (Baars, 2000). Map contact placed at top of most prominent and continuous limestone bed of the Honaker Trail Formation that forms a sequence of limestone cliffs down to the Colorado River. Variable thickness due to arbitrary boundaries, 320 to 380 ft

Ph — **Honaker Trail Formation (Middle and Upper Pennsylvanian)**—Blue-gray, thick-bedded, cliff-forming limestone, thin-bedded calcareous sandstone, and interbedded, slope-forming thin-bedded siltstone. Contains numerous fossil brachiopods, crinoids, bryozoa, corals, pelecypods, gastropods, and fusulinids that date the formation as Middle Pennsylvanian (middle Desmoinesian) to upper Pennsylvanian (upper Missourian) in age (Baars, 2000). Forms sequence of cyclic alternating limestone, sandstone, and siltstone beds that comprise the bulk of the canyon walls of along the Colorado River. Forms disconformable contact with underlying evaporites of the Paradox Formation in subsurface of the map area. Incomplete section; 600 to 800 ft exposed in map area

Contact–Contacts between bedrock units are plotted at the 1:4,000 scale on aerial photos and may not match the 1:24,000-scale contours

Fault–Dotted where concealed; bar and ball on downthrown side. Number is estimated fault separation in feet

Facies change–Line representing median of two-mile-wide regional facies change between Cutler Formation on northeast and Cedar Mesa Sandstone on southwest

Sinkhole–Enclosed drainage depressions, crack, or cave

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