Map Unit Properties Table: Chaco Culture National Historical Park

Investigators mapped the following units in Chaco Culture National Historical Park. A full list and descriptions of all the units are included in the GRI data for the park (chcu_geology.pdf). Bold text refers to sections in the report.

Age	Map Unit (Symbol)	Park Unit	Geologic Description	Geologic Features and Processes	Geologic Resource Management Issues	Geologic History
QUATERNARY (Holocene)	Earth dam (Qaf1)	Kin Ya'a Kin Bineola	An earth dam (**Qaf1**) in the Kin Ya'a unit of the park surrounds a flowing well. Earth dams mapped as part of **Qal** in the La Vida Mission quadrangle were built across washes to catch and retain storm water for irrigation and livestock. Dams across broader washes may be as long as 0.6 km (0.4 mi). Earth (dam fill) material was scoured out with scrapers from an extensive, nearly flat area in the lower reaches of the dry Kim-me-ni-oli channel.	None reported.	**Disturbed Lands Restoration**—in some places, earth dams have totally altered normal drainage and sediment deposition along the Kim-me-ni-oli Wash.	**Human Populations in Chaco Canyon**—built in the 1930s.
QUATERNARY (Holocene)	Soil, large area (Qsl)	Kin Bineola	Sedentary soil (not slope-wash deposits) mapped in large uninterrupted areas. Derived from bedrock, which may be mud, silt, or fine-grained sand. Where sand, the surface commonly has hummocks around shrubs, but troughs between are shallow (not as deep as in stabilized eolian sand). Slight to firm crust (caliche) on surface. Obscures bedrock.	**Upper Cretaceous Rocks and Fossils**—developed principally on mudstone of the Menefee Formation (**Kmf**); derived from weathering of Menefee bedrock. Contains small fragments of sandstone from bedrock, caliche chips, or ironstone chips abundant or sparse in troughs. Ants bring up chips of bedrock, especially ironstone chips, around their holes. **Alluvial Fill**—possibly equivalent to the Naha alluvium of Hack (1941) (**Qn**).	**Eolian Processes**—sandy soil areas and stabilized eolian sand areas may grade from one to the other. No issues of dust storms or eolian transport reported.	**Human Populations in Chaco Canyon**—may be equivalent to Naha alluvium (**Qn)**, and thus of interest for **Geoarcheology.**
QUATERNARY (Holocene)	Soil, small area (Qss)	Kin Bineola	Sedentary soil (not slope-wash deposits) mapped in small areas or within a larger area broken up by other map units. Derived from bedrock, which may be mud, silt, or fine-grained sand. Where sand, the surface commonly has hummocks around shrubs, but troughs between are shallow (not as deep as in stabilized eolian sand). Slight to firm crust (caliche) on surface. Obscures bedrock.	**Upper Cretaceous Rocks and Fossils**—developed principally on mudstone of the Menefee Formation (**Kmf**); derived from weathering of Menefee bedrock. Contains small fragments of sandstone from bedrock, caliche chips, or ironstone chips abundant or sparse in troughs. Ants bring up chips of bedrock, especially ironstone chips, around their holes. **Alluvial Fill**—possibly equivalent to the Naha Alluvium of Hack (1941) (**Qn**).	**Eolian Processes**—sandy soil areas and stabilized eolian sand areas may grade from one to the other. No issues of dust storms or eolian transport reported.	**Human Populations in Chaco Canyon**—may be equivalent to Naha alluvium (**Qn)**, and thus of interest for **Geoarcheology.**
QUATERNARY (Holocene and Pleistocene?)	Alluvium and eolian deposits (Qae)	Kin Bineola	Windblown silt and sand reworked by running water.	**Eolian Features**—occurs on mesas, benches, and in broad valleys.	**Eolian Processes**—provides material for dust storms and sand transport.	**Dynamic Sedimentation**—after incision of Chaco Canyon, sediments began to fill it, including windblown silt and sand and material transported by running water.
QUATERNARY (Holocene)	Slope-wash deposit (Qswd)	Kin Bineola	Most deposits developed on mudstone of the Menefee Formation (**Kmf**).	**Upper Cretaceous Rocks and Fossils**—may be partly mantled by chips and cobbles of Cretaceous sandstone from nearby outcrops or partly to fully mantled by chips of ironstone from broken concretions. **Sheetwash Alluvium and Slope-Wash Deposits and**—deposited by overland flow. Occurs on gently sloping smooth surfaces swept bare of vegetation.	**Eolian Processes**—margins of slope-wash areas commonly irregular; slope-wash material interfingers with stabilized eolian sand or soil. No issues with dust storms or eolian transport reported.	**Dynamic Sedimentation**—after incision of Chaco Canyon, sediments began to fill it, including material deposited by overland flow.

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Age	Map Unit (Symbol)	Park Unit	Geologic Description	Geologic Features and Processes	Geologic Resource Management Issues	Geologic History
QUATERNARY (Holocene)	Alluvium (Qal)	Chaco Canyon Kin Bineola	Sand, silt, and clay deposited along major drainages. Generally about 1.5 m (5 ft) thick, but ranges from less than 3 m (10 ft) to more than 15 m (15 m) in Escavada Wash channel.	**Upper Cretaceous Rocks and Fossils**—derived from shale or sandstone bedrock, or reworked from deposits of older alluvium. Contains clasts of sandstone and sideritic ironstone from local bedrock. Contains fragments of Cretaceous petrified wood. **Chaco Canyon**—occurs in the lowest channels cut into floodplains of larger ephemeral streams. Makes up bed of Chaco Wash. **Dynamic Sedimentation and Arroyo Development**—stream-deposited clay, silt, sand, and gravel along major drainages. **Alluvial Fill**—"modern alluvium" mapped in Chaco Canyon and Kin Bineola units.	**Disturbed Lands Restoration**—earth dams are part of unit **Qal** in the Kin Bineola unit of the park (see description for **Qaf1**). **Piping**—not an issue for piping, which occurs in older alluvial fill on the floor of Chaco Canyon.	**Dynamic Sedimentation**—modern alluvium in stream channels.
QUATERNARY (upper Holocene)	Alluvial deposits, unit 1 (Qa1)	Kin Ya'a	Mostly light-yellowish-gray sand and gravel. Generally thin, probably does not exceed 3 m (10 ft) thick.	**Chaco Canyon**—deposited in arroyos and on valley floors since the development of Chaco Arroyo. Locally incised by very recent arroyos, **Dynamic Sedimentation and Arroyo Development**—generally mantles the broad valley floodplains downstream from the arroyos. Underlain by alluvium of unit 2 (**Qa2**). **Alluvial Fill**—mapped in Kin Ya'a unit; Robertson (1992) did not use terms of Hack (1941) such as "Naha" or "Tsegi" to differentiate alluvial deposits. **Eolian Features**—includes some eolian sand reworked by flood waters. **Tinajas and Charcos**—**Qa1** includes minor clay and silt deposited in ephemeral ponds and reservoirs.	**Piping**—potential for piping in tributary canyons and the walls of Chaco Arroyo.	**Human Populations in Chaco Canyon**—deposited since the beginning of the latest cycle of arroyo cutting.
QUATERNARY (Holocene)	Naha Alluvium of Hack (1941) (Qn)	Pueblo Pintado Chaco Canyon	Grayish brown, poorly consolidated, laminated and cross-stratified sand and silt that fill ephemeral washes. **Qn** overlies Tsegi Alluvium along deep arroyos. Ranges from 3 to 6 m (10 to 20 ft) thick.	**Chaco Canyon**—as shown on source maps and in the GRI GIS data, the floor of Chaco Canyon is covered by **Qn** and **Qnt**. **Alluvial Fill**—use of "Naha Alluvium" in Chaco Canyon may not be appropriate because the timing of deposition of this alluvium is unclear and a correlation between the type locality in Arizona and Chaco Canyon has not been established. **Sheetwash Alluvium and Slope-Wash Deposits**—**Qn** contains some rounded chert and quartzite pebbles, and some sheetwash with blocks of sandstone along valley walls.	**Piping**—**Qn** has potential for piping in tributary canyons and the walls of Chaco Arroyo.	**Human Populations in Chaco Canyon**—**Qn** relates to the most intense occupation of Chaco Canyon. Contains abundant archeological remains, especially pottery, along Chaco Wash. Contains abundant ceramic artifacts near Pueblo Pintado. **Geoarcheology**—**Qn** is significant for studying the relationships between prehistoric humans and the environment at Chaco Canyon.

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Age	Map Unit (Symbol)	Park Unit	Geologic Description	Geologic Features and Processes	Geologic Resource Management Issues	Geologic History
QUATERNARY (Holocene)	Naha and Tsegi Alluviums of Hack (1941) (Qnt)	Chaco Canyon	These alluviums were mapped as a single undivided unit in parts of Chaco Canyon. **Naha Alluvium**: grayish brown, friable to slightly hard, thinly laminated and cross-stratified sand and silt in discontinuous layers. Thickness ranges from 10 ft (3 m) to more than 6 m (20 ft). **Tsegi Alluvium**: yellowish-gray or grayish-brown, firmly consolidated, fine to coarse sand, silt, and clay containing several clay and humus-rich layers. About 3 m (10 ft) thick.	**Chaco Canyon**—as shown on source maps and in the GRI GIS data, the floor of Chaco Canyon is covered by **Qn** and **Qnt**. **Alluvial Fill**—use of "Naha Alluvium" in Chaco Canyon may not be appropriate because the timing of deposition of this alluvium is unclear and a correlation between the type locality in Arizona and Chaco Canyon has not been established. **Sheetwash Alluvium and Slope-Wash Deposits**—**Qnt** contains some sheetwash alluvium and alluvial fans along valley walls.	**Piping**—**Qnt** has potential for piping in tributary canyons and the walls of Chaco Arroyo.	**Human Populations in Chaco Canyon**—**Tsegi alluvium** was deposited before pottery was in use but does contain a few stone tools from archaic cultures. **Geoarcheology**—**Qnt** is significant for studying the relationships between prehistoric humans and the environment at Chaco Canyon.
QUATERNARY (Holocene)	Alluvial deposits, unit 2 (Qa2)	Kin Ya'a	Yellowish-gray, unconsolidated silt, sand, and gravel. Grades upslope into colluvium (**Qc**). Observed thickness 0–4 m (0–13 ft), but probably more than 8 m (26 ft) thick in some alluviated valleys.	**Chaco Canyon**—deposited in aggraded valley bottoms and on floodplains. **Alluvial Fill**—**Qa2** mapped by Robertson (1992) in Kin Ya'a unit; did not use terms of Hack (1941) such as "Naha" or "Tsegi." **Eolian Features**—**Qa2** contains thin clay lenses and eolian deposits.	**Piping**—**Qa2** has potential for piping in tributary canyons and the walls of Chaco Arroyo. **Eolian Processes**—locally, contains thin clay lenses and eolian deposits. Generally stabilized by vegetation and incipient soil formation. Dust storms and sand transport not known to be an issue.	**Dynamic Sedimentation**—deposited before the beginning of the latest cycle of arroyo cutting.
QUATERNARY (upper Pleistocene to Holocene)	Sheetwash alluvium (Qsw)	Chaco Canyon	Poorly consolidated clay, silt, and coarse to medium sand containing rock fragments ranging from pebbles to large sandstone slabs. Most clasts are from underlying Menefee Formation. Chiefly sheetwash material derived from shale and sandstone bedrock on gently sloping tops of mesas and gently to steeply sloping valley walls. In part derived from older surficial deposits. Locally well-cemented on southern side of Chaco Canyon between Wijiji and Pueblo del Arroyo sites. Up to 6 m (20 ft) thick.	**Alluvial Fill**—small areas of gravelly sheetwash alluvium (**Qsw**) along Fajada Wash may be equivalent to gravelly Jeddito alluvium (**Qj**) in the gravel pit 0.8 km (0.5 mi) southwest of the park headquarters. May also be equivalent to "Fajada gravel" of Hall (1977, 2010). **Sheetwash Alluvium and Slope-Wash Deposits**—**Qsw** was deposited by overland flow. **Eolian Features**—**Qsw** locally covered by unmapped eolian sand.	**Rockfall**—**Qsw** includes small unmapped rockfalls and talus cones derived from bedrock on steep valley walls, and colluvium subjected to creep on steep slopes. **Paleontological Resource Inventory and Monitoring**—**Qsw** contains petrified wood.	**Dynamic Sedimentation**—after incision of Chaco Canyon, sediments began to fill it, including material deposited by sheetfloods.
QUATERNARY (upper Pleistocene to upper Holocene)	Eolian sand (Qes)	Chaco Canyon	Fine-grained, windblown sand. Includes both younger and older deposits. **Younger eolian sand**: White, well-sorted, cross-stratified loose quartz sand in active barchan and climbing dunes. More than 12 m (40 ft) thick in active dune fields along the Chaco River and Chaco Wash. **Older eolian deposits**: Light-brown, slightly consolidated, fine to medium sand containing subrounded to rounded, frosted quartz grains in stabilized linear dunes and sand sheets on the uplands. More than 2 m (7 ft) thick in older sand deposits.	**Eolian Features**—**Qes** composes dunes and sand sheets.	**Eolian Processes**—**Qes** generally stabilized by vegetation. Younger eolian sand may be prone to transport.	**Dynamic Sedimentation**—after incision of Chaco Canyon, sediments began to fill it, including windblown sand.

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Age	Map Unit (Symbol)	Park Unit	Geologic Description	Geologic Features and Processes	Geologic Resource Management Issues	Geologic History
QUATERNARY (Pleistocene to Holocene)	Older eolian deposits (Qoe)	Kin Ya'a	Moderate-yellowish-brown, pale-reddish-brown, and dusky-yellow, fine- to very fine grained silt; somewhat clayey and oxidized; caliche moderately to well developed. Some older eolian deposits (**Qoe**) are mixed with and mapped as colluvium (**Qc**), older alluvium (**Qoa**), and pediment gravel (**Qp**). Up to 6 m (20 ft) thick.	**Eolian Features**—**Qoe** covers large areas as blanket-like deposits on flanks and tops of ridges and low mesas; lightly masks many areas mapped as bedrock. Large-scale seif dunes, some combined with barchan dunes, rise 1–6 m (3–20 ft) above the blanket-like deposits in places.	**Eolian Processes**—semi-consolidated sand and silt, commonly stabilized by vegetation and soil formation, thus dust storms and sand transport are not known to be an issue.	**Dynamic Sedimentation**—after incision of Chaco Canyon, sediments began to fill it, including windblown sand and silt.
QUATERNARY (Pleistocene? to Holocene)	Alluvial fan deposits (Qf)	Kin Ya'a	Poorly sorted, unconsolidated sand, silt, and gravel. Grades laterally into colluvium (**Qc**).	**Chaco Canyon**—**Qf** consists of fan-shaped deposits on side canyons and in the upper parts of some main stream valleys. **Eolian Features**—parabolic dunes are associated with large alluvial fans (**Qf**) at the mouths of tributary canyons. **Badlands**—small alluvial fans (**Qf**) form in badlands topography as water and sediment pass through soil pipes and discharge at the base of slopes.	**Piping**—small alluvial fans (**Qf**) form as a result of piping in badlands topography.	**Cut-and-Fill Cycles**—**Qf** formed by aggradation where the detrital bed load exceeded the capacity of the streams to transport it out of the canyon.
QUATERNARY (Pleistocene to Holocene)	Colluvium (Qc)	Kin Ya'a	Unsorted to poorly sorted silt, sand, and gravel deposited on valley walls between talus slopes and alluvium (**Qa1**, **Qa2**) in stream valleys; includes some valley alluvium (**Qa1**, **Qa2**). Grades laterally into fan (**Qf**) deposits.	**Sheetwash Alluvium and Slope-Wash Deposits**—sheetwash has moved some **Qc**. **Eolian Features**—deposits of **Qc** include some eolian sand (**Qe**).	**Rockfall**—**Qc** material has moved by mudflow processes and includes some talus debris (**Qt**).	**Dynamic Sedimentation**—**Qc** deposited since the formation of Chaco Canyon.
QUATERNARY (upper Pleistocene to lower Holocene)	Jeddito Alluvium of Hack (1941) (Qj)	Chaco Canyon	Dark-yellowish-brown sand containing moderate yellowish-brown, angular, pebble- to cobble-sized clasts of sandstone and very dark brown to black, pebble-sized clasts of ironstone. Along Kin Klizhin and Fajada washes, most clasts are from the underlying Menefee Formation (**Kmf**). Forms a terrace about 7 m (23 ft) above the Chaco River, Fajada Wash, and Kin Klizhin Wash. Maximum thickness along Fajada Wash about 10 m (30 ft).	**Quaternary Fossils**—**Qj** may contain proboscidian remains. **Alluvial Fill**—use of "Jeddito Alluvium" in Chaco Canyon may not be appropriate because the timing of deposition of this alluvium is unclear and a correlation between the type locality in Arizona and Chaco Canyon has not been established. Along Fajada Wash, a reddish-brown, well-developed Altithermal (dry postglacial interval) soil formed in the upper part of the alluvium. Altithermal soil is exposed locally in the lower parts of arroyo walls along Chaco Wash, which indicates that near the center of the wash, **Qj** forms a deep and rarely exposed fill. **Sheetwash Alluvium and Slope-Wash Deposits**—some **Qj** along Fajada Wash was deposited by overland flow.	**Abandoned Mineral Lands**—Pleistocene gravel deposit (exact unit unknown) was mined for sand and gravel for administrative uses until the late 1980s. **Paleontological Resource Inventory and Monitoring**—the ongoing inventory has thus far focused on Upper Cretaceous rocks in Chaco Culture National Historical Park. No proboscidian remains found, to date. **Piping**—**Qj** has potential for piping in tributary canyons and the walls of Chaco Arroyo.	**Human Populations in Chaco Canyon** and **Geoarcheology**—deposition of **Qj** predates human occupation of Chaco Canyon, though some clasts in **Qj** were a source of flaking material for the manufacture of prehistoric stone tools.

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Age	Map Unit (Symbol)	Park Unit	Geologic Description	Geologic Features and Processes	Geologic Resource Management Issues	Geologic History
QUATERNARY (upper Pleistocene)	Gravelly sand (Qgs7)	Chaco Canyon	Very pale brown, dark-yellowish-brown, or grayish orange, gravelly, medium to coarse sand containing pebbles averaging about 2 cm (1 in) across. Pebbles decrease in abundance upward through a deposit. Size and composition of clasts varies with location and proximity of source. Deposits occur as sheets overlying pediment-like surfaces that cut across nonresistant bedrock and slope toward the Chaco River or other local major valleys. The three youngest geomorphic levels of gravelly sand are present in the park area, and range from 18–60 m (60–200 ft) above the local drainage. **Qgs7** covers the youngest and lowest of three erosion surfaces in the park.	**Chaco Canyon**—at least seven erosion surfaces and their associated gravelly sand deposits are in the drainage basin of the Chaco River. Each reflects an erosional episode related to changes in the grade of the Chaco River or the San Juan River. Signifies greater stream power than today.	**Abandoned Mineral Lands**—Pleistocene gravel deposit (exact unit unknown) was mined for sand and gravel for administrative uses until the late 1980s.	**Human Populations in Chaco Canyon**—represents an ancient stream network, which predates habitation of Chaco Canyon. **Chaco Canyon**—marks one of seven erosion surfaces that represent the downcutting of the Chaco River (and the development of Chaco Canyon). **San Juan Basin**—quartzitic sandstone, quartz, and chert clasts are mostly from the Paleocene Ojo Alamo Sandstone, which crops out 12 km (7 mi) north of the park; ironstone and clinker (baked coal) are mostly from the Fruitland Formation (**Kf**); sandstone and ironstone clasts along the Chaco River are mostly from the Cliff House Sandstone (**Kch**) and Menefee Formation (**Kmf**).
QUATERNARY (upper Pleistocene)	Gravelly sand (Qgs6)	Chaco Canyon	See description for **Qgs7**. **Qgs6** is about 24 m (80 ft) above present drainage level. As much as 6 m (20 ft) thick.	**Chaco Canyon**—at least seven erosion surfaces and their associated gravelly sand deposits are in the drainage basin of the Chaco River. Each reflects an erosional episode related to changes in the grade of the Chaco River or the San Juan River. Signifies greater stream power than today	**Abandoned Mineral Lands**—Pleistocene gravel deposit (exact unit unknown) was mined for sand and gravel for administrative uses until the late 1980s.	**Human Populations in Chaco Canyon**—represents an ancient stream network, which predates habitation of Chaco Canyon. **Chaco Canyon**—marks one of seven erosion surfaces that represent the downcutting of the Chaco River (and the development of Chaco Canyon).
QUATERNARY (upper Pleistocene)	Gravelly sand (Qgs5)	Chaco Canyon	See description for **Qgs7**. **Qgs5** covers the oldest and highest of three erosion surfaces in the park.	**Chaco Canyon**—at least seven erosion surfaces and their associated gravelly sand deposits are in the drainage basin of the Chaco River. Each reflects an erosional episode related to changes in the grade of the Chaco River or the San Juan River. Signifies greater stream power than today	**Abandoned Mineral Lands**—Pleistocene gravel deposit (exact unit unknown) was mined for sand and gravel for administrative uses until the late 1980s.	**Human Populations in Chaco Canyon**—represents an ancient stream network, which predates habitation of Chaco Canyon. **Chaco Canyon**—marks one of seven erosion surfaces that represent the downcutting of the Chaco River (and the development of Chaco Canyon).
QUATERNARY (Pleistocene)	Gravel (Qg)	Chaco Canyon	Quartzitic and lithic pebbles and cobbles. Overlies Cliff House Sandstone, at northern end of West Mesa. Thickness about 1.5 m (5 ft).	**Upper Cretaceous Rocks and Fossils**—composed largely of chunks of sandstone and fragmented ironstone concretions of the Menefee Formation. **Chaco Canyon**—Pleistocene gravel deposited on uplands. Differs markedly from terrace gravels of the Chaco River.	**Abandoned Mineral Lands**—Pleistocene gravel deposit (exact unit unknown) was mined for sand and gravel for administrative uses until the late 1980s.	**Human Populations in Chaco Canyon**—represents an ancient stream network, which predates habitation of Chaco Canyon. **Development of Chaco Canyon**—signifies greater stream power than today.

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Age	Map Unit (Symbol)	Park Unit	Geologic Description	Geologic Features and Processes	Geologic Resource Management Issues	Geologic History
UPPER CRETACEOUS	Pictured Cliffs Sandstone (Kpc)	Chaco Canyon	**Upper part**: yellowish-gray to grayish-orange, thick-bedded and cross-bedded, well-sorted, friable, fine-grained sandstone comprises the upper part of the formation. **Lower part**: consists of alternating thin beds of yellowish-gray to moderate-brown, fine-grained to very fine grained sandstone and light-gray to dark-gray, silty shale. Total thickness about 18 m (60 ft).	**Upper Cretaceous Rocks and Fossils**—**Kpc** contains fossil marine invertebrates and casts and impressions of burrows (the trace fossil *Ophiomorpha major*) whose outer walls have a knobby appearance that resembles a corn cob; indicative of nearshore marine environment. **Upper part** forms cliffs, and contains brown, hard, round, slabby, calcareous sandstone concretions that are parallel to bedding and as large as 1.2 m (4 ft) across. **Lower part** forms low bluffs, and contains thin discontinuous layer of hard fine-grained ironstone.	**Paleontological Resource Inventory and Monitoring**—ongoing inventory since 2005 of Upper Cretaceous rocks in Chaco Culture National Historical Park indicates very high potential for new and scientifically significant material in **Kpc**.	**Western Interior Seaway**—**Kpc** represents final retreat of the seaway from the San Juan Basin. Coastal delta front, beach, and stream channel settings.
UPPER CRETACEOUS	Lewis Shale (Kl)	Chaco Canyon Pueblo Pintado	**Upper part**: calcareous sandy shale that contains decreasing abundance downward of light-brown sandstone beds 0.3-1.5 m (1-5 ft) thick, and is transitional upward with the Pictured Cliffs Sandstone (**Kpc**). **Middle part**: light-gray to dark-olive or olive-gray claystone and siltstone that contains a few thin sandstone zones and scattered beds of sandy concretionary limestone. **Lower part**: sandy and transitional into underlying Cliff House Sandstone (**Kch**). Total thickness about 30 m (100 ft).	**Upper Cretaceous Rocks and Fossils**—calcareous concretions in the formation contain marine invertebrate fossils equivalent in age to middle Pierre Shale (Upper Cretaceous, Campanian) of eastern Colorado. Bentonite beds in Lewis Shale originated as volcanic ash.	**Paleontological Resource Inventory and Monitoring**—ongoing inventory of Upper Cretaceous rocks in Chaco Culture National Historical Park indicates very high potential for new and scientifically significant material in **Kl**.	**Western Interior Seaway**—represents marine deposition between a major transgressive–regressive cycle. Offshore marine setting.
UPPER CRETACEOUS	Cliff House Sandstone (Kch) Upper sandstone/bed (Kchu) White to light-gray sandstone, upper unit (Kchwu) White to light-gray sandstone, lower unit (Kchwl) Middle sandstone (Kchm) Intermediate unit (Kchi) Lower sandstone (Kchl)	Chaco Canyon Pueblo Pintado	White to dark -yellowish-orange, thin- to thick-bedded, fine- to coarse-grained, lenticular and cross-bedded or massive sandstone. Contains gray or brown carbonaceous shale lenses. Intertongues with both Lewis Shale and Menefee Formation. Some tongues of Menefee Formation are mapped with the Cliff House; other tongues are mapped separately. Cliff House Sandstone is as much as 430 ft (131 m) thick.	**Upper Cretaceous Rocks and Fossils**—forms high bold cliffs and ridges. **Kchl** dominates the view in the Chaco Canyon. Contains *Ophiomorpha major*, which is a trace fossil (burrows) indicative of a nearshore marine environment and activity of marine fossil invertebrates, and highly fossiliferous beds containing clams. **Quaternary Fossils**—may contain pack rat (*Neotoma* spp.) middens in cave shelters. **Cave Shelters**—cave shelters form along the shale-sandstone contact between the Cliff House Sandstone and Menefee Formation.	**Coal Resources and Mining**—contains coal beds, particularly in **Kchl**. **Rockfall**—stratigraphic arrangement of overlying Cliff House Sandstone and underlying Menefee Formation creates rockfall hazards. **Paleontological Resources Inventory and Monitoring**—one of the two most fossiliferous units in Chaco Culture National Historical Park; the other is **Kmf**. Preliminary results of an ongoing inventory indicate that the potential for new and scientifically significant material is very high. Planning and research strategy in progress. **Efflorescence**—building stone in Chacoan structures prone to salt weathering, which may accelerate deterioration of stone and mortar.	**Western Interior Seaway**—represents a marine transgression. Nearshore marine environment such as barrier islands.

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Age	Map Unit (Symbol)	Park Unit	Geologic Description	Geologic Features and Processes	Geologic Resource Management Issues	Geologic History
UPPER CRETACEOUS	Menefee Formation (Kmf)	Chaco Canyon	Heterogeneous sequence of thick, lenticular beds of grayish-yellow to brown, fine- to medium-grained, cross-bedded sandstone and interbeds of dusky-yellow to olive-gray, sandy shale and mudstone, moderate-brown, sandy limestone; and lenticular beds of carbonaceous shale and shaly coal; also, claystone, siltstone, and black carbonaceous shale. Exposed thickness is about 165 m (540 ft).	**Upper Cretaceous Rocks and Fossils**—forms slopes that underlie the steep canyon walls in Chaco Culture National Historical Park. Widely exposed in southern San Juan Basin. Base of the formation crops out 30 km (19 mi) south of the park. Very fossiliferous, including petrified wood, casts of palm leaves and bark impressions, termite burrows, fragmentary dinosaur bones, turtle specimens, and crocodilian remains. **Badlands**—badlands topography common on exposures of Menefee Formation, especially **Kmfaj** (see below). **Cave Shelters**—cave shelters form along the shale-sandstone contact between the Cliff House Sandstone and Menefee Formation.	**Coal Resources and Mining**—coal beds occur sporadically in the upper 75 m (250 ft). The coal beds are commonly burned at the outcrop; red outcrops across from Casa Chiquita are result of burned coal. **Rockfall**—stratigraphic arrangement of overlying Cliff House Sandstone and underlying Menefee Formation creates rockfall hazards. **Paleontological Resources Inventory and Monitoring**—one of the two most fossiliferous units in Chaco Culture National Historical Park; the other is Cliff House Sandstone. Preliminary results of an ongoing inventory indicate a very high potential for new and scientifically significant material, especially in **Kmf**. Planning and research strategy in progress.	**Western Interior Seaway**—deposited between a major marine regression (retreat) and transgression (advance). Lowland swamp, estuary, and beach settings.
UPPER CRETACEOUS	Tongues of Menefee Formation (Kmft)	Chaco Canyon	Gray and brown, lenticular sandstone interbedded with black, carbonaceous shale, gray claystone and siltstone. As much as 24 m (80 ft) thick. Scott et al. (1984) showed **Kmft** as underlying **Kchu** and intertonguing with **Kch**. Mytton and Schneider (1987) showed **Kmf** as underlying **Kchu** and intertonguing with **Kchl**, **Kchi**, **Kchwl**, **Kchm**, and **Kchwu**.	**Upper Cretaceous Rocks and Fossils**—**Kmft** represents two or more separate tongues extending and thinning into the Cliff House Sandstone northward from main body of Menefee Formation (**Kmf**). Stratigraphic connection, however, has since been removed by erosion in the area. No mention of fossils in source map data.	**Coal Resources and Mining**—contains some thin beds of highly weathered coal.	**Western Interior Seaway**—represents shoreward lagoons southwest of Cliff House Sandstone barrier islands.
UPPER CRETACEOUS	Menefee Formation Allison Member (Kmfa)	Kin Bineola	Interbedded sequence of yellowish gray and dusky yellow to grayish olive shale and minor siltstone; very pale orange to pale yellowish brown, very fine-grained to medium-grained, well to poorly sorted, lenticular, cross-bedded, calcareous sandstone; and minor carbonaceous shale. As much as 609 m (1,998 ft) thick.	**Upper Cretaceous Rocks and Fossils**—forms slopes that underlie the steep canyon walls in Chaco Culture National Historical Park. Menefee Formation is very fossiliferous, including petrified wood, casts of palm leaves and bark impressions, termite burrows, fragmentary dinosaur bones, turtle specimens, and crocodilian remains.	**Coal Resources and Mining**—contains a few lenticular subbituminous coal beds less than 35 cm (14 in) thick. **Paleontological Resources Inventory and Monitoring**—one of the two most fossiliferous units in Chaco Culture National Historical Park; the other is Cliff House Sandstone. Preliminary results of an ongoing inventory indicate a very high potential for new and scientifically significant material, especially in the Menefee Formation. Planning and research strategy in progress.	**Western Interior Seaway**—deposited between a major marine regression (retreat) and transgression (advance). Continental setting.
UPPER CRETACEOUS	Menefee Formation Allison Member, Juans Lake Beds of Miller (1984) (Kmfaj)	Kin Bineola	Fine-grained, light-gray to white, thin- to thick-bedded sandstone and dark-gray mudstone that weathers light gray. Bands of dusky-brown organic-rich mudstone (humate) several feet thick are in upper part of beds. Carbonaceous shale units are common. Base of **Kmfaj** is defined as the lowest occurrence of calcareous concretions. About 750 ft (230 m) thick.	**Upper Cretaceous Rocks and Fossils**—characterized by numerous large calcareous concretions that are present at base or top of some sandstone units, but are less common downward. The presence of calcareous concretions distinguishes this unit from lower part of Allison Member (**Kmfal**). **Kmfaj** also contain small ironstone (siderite) concretions scattered along individual horizons or coalescing into thin beds. Fossiliferous, especially in badlands terrain. **Badlands**—primary unit that forms badlands topography in Chaco Culture National Historical Park.	**Coal Resources and Mining**—very local thin coal lenses occur in uppermost part of beds. **Paleontological Resources Inventory and Monitoring**—one of the two most fossiliferous units in Chaco Culture National Historical Park; the other is Cliff House Sandstone. Preliminary results of an ongoing inventory indicate a very high potential for new and scientifically significant material, especially in the Menefee Formation. Planning and research strategy in progress.	**Western Interior Seaway**—deposited between a major marine regression (retreat) and transgression (advance).Continental setting. Later, concretions developed underground as groundwater flowed through sedimentary strata.

Investigators mapped the following units in Chaco Culture National Historical Park. A full list and descriptions of all the units are included in the GRI data for the park (chcu_geology.pdf). Bold text refers to sections in the report.

Age	Map Unit (Symbol)	Park Unit	Geologic Description	Geologic Features and Processes	Geologic Resource Management Issues	Geologic History
UPPER CRETACEOUS	Menefee Formation Lower part of Allison Member (Kmfal)	Kin Bineola	Fine-grained sandstone, gray mudstone, and minor amounts of siltstone; no calcareous concretions and few ironstone (siderite) concretions. About 735 ft (225 m) thick, of which only the uppermost 35 ft (11 m) is exposed in the La Vida Mission quadrangle.	**Upper Cretaceous Rocks and Fossils**—no calcareous concretions and few siderite concretions. Menefee Formation is very fossiliferous, including petrified wood, casts of palm leaves and bark impressions, termite burrows, fragmentary dinosaur bones, turtle specimens, and crocodilian remains.	**Paleontological Resources Inventory and Monitoring**—one of the two most fossiliferous units in Chaco Culture National Historical Park; the other is Cliff House Sandstone. Preliminary results of an ongoing inventory indicate a very high potential for new and scientifically significant material, especially in the Menefee Formation. Planning and research strategy in progress.	**Western Interior Seaway**—deposited between a major marine regression (retreat) and transgression (advance). Continental setting.
UPPER CRETACEOUS	Crevasse Canyon Formation Gibson Coal Member (Kcg)	Kin Ya'a	Lithology highly variable and laterally discontinuous. Includes very light to dark-gray carbonaceous shale, siltstone, and claystone; and yellowish-gray and grayish-yellow to white, poorly to well-sorted sandstone. Thickness ranges from 104 m (341 ft) to 37 m (121 ft).	**Upper Cretaceous Rocks and Fossils**—most of the sandstone beds appear to represent estuarine, fluvial-channel, distributary-channel, or splay deposits. Contacts generally sharp, but locally intertongue with, or grade laterally into, tidal-channel and marine-beach and bar deposits of the overlying Hosta Tongue (**Kplh**; see GRI GIS data) and underlying Dalton Sandstone Member of the Crevasse Canyon Formation (**Kcda**). Contain carbonaceous plant debris, petrified logs; some beds are bioturbated.	**Coal Resources and Mining**—contains 12 or more lenticular and discontinuous, subbituminous coal beds, 15–36 cm (6–14 in) thick. **Paleontological Resource Inventory and Monitoring**—ongoing inventory of Upper Cretaceous rocks in Chaco Culture National Historical Park indicate a very high potential for new and scientifically significant material.	**Western Interior Seaway**—represents marine regression/retreat. Lagoon, estuary, and beach settings.
UPPER CRETACEOUS	Crevasse Canyon Formation Dalton Sandstone Member (Kcda)	Kin Ya'a	Generally very light gray to yellowish gray and very pale orange sandstone. 25–55 m (82–180 ft) thick.	**Upper Cretaceous Rocks and Fossils**—forms prominent cliffs consisting of 1–3 massive units, each 2–22 m (7–72 ft) or more thick. Contains abundant carbonized plant debris and detritus, fish teeth, and broken shell fragments; some beds are bioturbated or burrowed, and contain the trace fossils *Ophiomorpha*, *Thalassinoides*, and *Skolithos*.	**Paleontological Resource Inventory and Monitoring**—ongoing inventory of Upper Cretaceous rocks in Chaco Culture National Historical Park indicates a very high potential for new and scientifically significant material.	**Western Interior Seaway**—represents marine regression/retreat. Lagoon, tidal, estuarine, foreshore, upper shoreface, and lower shoreface settings.