Map Unit Properties Table: Yucca House National Monument

Colored rows indicate units mapped within Yucca House National Monument.

Age	Map Unit (Symbol)	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
QUATERNARY	Alluvium (Qal)	Alluvium in the park area is an unconsolidated mixture of sorted silt, sand, and gravel that is deposited in stream beds and floodplains. Locally, this unit may also include soil and some colluvium (see **Qt** and **Ql**) and aeolian deposits (see **Qs**). In areas of relatively rapid flow, coarser gravels and sands dominate the deposits, whereas areas of stagnant water or slower flow tend to concentrate muds and silts.	**Connections between Geology and Park Stories**—Boulders from this unit were used by the ancestral Puebloan people as building stones. Soluble salts occur on this unit as a product of weathering of **Km**.	**Disturbed Land Restoration**—Sand and gravel resources in units such as **Qal** are extracted from local quarries adjacent to the monument. One abandoned pit is located southwest of the monument and an access road is still in the process of being restored. **Springs and Seeps**—Unconsolidated gravels permit the flow of groundwater to emerge as seeps and springs in the monument. Springs emerging from surficial deposits tend to be less mineralized than those emerging from **Km**. **Surficial Features and Processes**—Alluvium reflects the active processes of erosion and deposition occurring on the landscape at Yucca House National Monument. **Qal** occurs within the intermittent fluvial system at the monument. **Qal** occurs in two small channels that drain from the mound in the center of the monument and Aztec Spring.	**Cenozoic Era**—**Qal** and **Qs** represent active processes on the landscape.
	Eolian sand and silt (Qs)	Eolian (also spelled "aeolian") deposits are transported and winnowed by the wind. In general, they are fine-grained and may form dunes or sand sheets.	**Connections between Geology and Park Stories**—Blowing sand can bury vegetation or biological soil crusts.	**Disturbed Land Restoration**—Sand and aeolian soils in units such as **Qs** are targets for local quarries. The Weminuche Construction Company is interested in these types of deposits for brick-making materials. **Aeolian Features and Processes**—Windblown deposits may collect atop other surficial units within the monument.	
	Talus (Qt)	Talus collects at the base of slopes as an unsorted deposit of blocky rubble. Talus forms through mass wasting by gravitational falling, rolling, or sliding of debris that dislodged from the rocky slopes.	**Connections between Geology and Park Stories**—Groundwater flowing through this unit on the slopes of Sleeping Ute Mountain emerges as springs such as those in the monument. The ancestral Puebloan people focused settlements around these springs. **Paleontological Resources**—Surficial deposits may yield paleontological resources such as packrat middens or pollen if significant cavities are present.	**Springs and Seeps**—Unconsolidated deposits at the base of slopes permit the flow of groundwater to emerge as seeps and springs. **Slope Movements**—Talus collects through mass wasting processes at the base of slopes.	**Cenozoic Era**—Deposits such as **Qt**, **Ql**, and **Qb** collect at the base of slopes reflecting onging processes that wedge rocks apart and transport them downslope.
	Landslide deposits (Ql)	Similar to **Qt**, landslide deposits form through mass wasting processes. **Ql** is usually a more cohesive block of mixed material sliding downslope over a relatively confined zone or surface, in contrast to **Qt**.	**Connections between Geology and Park Stories**—Groundwater flowing through this unit off the slopes of Sleeping Ute Mountain emerges as springs such as those in the monument. The ancestral Puebloan people focused settlements around these springs. **Paleontological Resources**—Surficial deposits may yield paleontological resources.	**Springs and Seeps**—Unconsolidated deposits at the base of slopes permit the flow of groundwater to emerge as seeps and springs. **Slope Movements**—Slides are associated with active mass wasting processes.	
	Block rubble (Qb)	Locally, **Qb** exists as blocks of porphyry (see **TKdp**) lying on unevenly eroded surfaces. Irregular, hummocky topography develops within this unit.	**Connections between Geology and Park Stories**—Groundwater flowing through this unit off the slopes of Sleeping Ute Mountain emerges as springs such as those in the monument. The ancestral Puebloan people focused settlements around these springs. **Paleontological Resources**—Unit has the potential to yield micropaleontological resources such as pollen and packrat middens.	**Springs and Seeps**—Unconsolidated deposits at the base of slopes permit the flow of groundwater to emerge as seeps and springs. **Slope Movements**—Block rubble collects through mass wasting processes at the base of slopes.	

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Age	Map Unit (Symbol)	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
QUATERNARY	Fanglomerate (Qfg)	This unit includes cobbles and boulders from **Kpl** as the coarse-grained component of the upper part of an alluvial fan. Alluvial fans form at the base of slope deposited by streams where they issue from narrow mountain valleys onto more level, open areas. Many of these deposits may also be derived from slope movements such as debris flows mixing with the alluvial deposits. Overlapping fanglomerates form bajadas along the base of a slope.	**Connections between Geology and Park Stories**—Groundwater flowing through this unit off the slopes of Sleeping Ute Mountain emerges as springs such as those in the monument. The ancestral Puebloan people focused settlements around these springs. **Paleontological Resources**—Unit has the potential to yield micropaleontological resources such as pollen.	**Springs and Seeps**—As part of the alluvial fan piedmont of the northeastern slope of Sleeping Ute Mountain, unconsolidated deposits such as **Qfg** permit the flow of groundwater to emerge as seeps and springs in the monument. **Slope Movements**—Fanglomerates are associated with active mass wasting processes as drainages from mountain slopes intersect more level valley bottoms and deposit coarse sediments at their canyon mouths.	**Cenozoic Era**—Fanglomerates form a mantle to the flanks of Sleeping Ute Mountain reflecting an abrupt change in slope where the streams draining the sides of the mountain deposit their sediment load.
	Pediment deposits (Qpg)	**Qpg** consists of poorly sorted, angular to well-rounded sand, pebbles, cobbles, and boulders of igneous rocks (see **TKdp**) that are strewn over erosional surfaces that extend radially from mountainous (sloped) areas. Locally, these deposits occur near the Abajo Mountains and Sleeping Ute Mountain. *Note*: Because pediment surfaces are erosional features, calling them "deposits" is somewhat of a misnomer. These are stream terraces that enter Montezuma Valley from bedrock-confined tributaries and coalescing alluvial fans (M. Gillam, geologist, written communication, 14 May 2013).	**Connections between Geology and Park Stories**—Boulders from this unit were used by the ancestral Puebloan people as building stones. Groundwater flowing through this unit on the slopes of Sleeping Ute Mountain emerges as springs such as those in the monument. The ancestral Puebloan people focused settlements around these springs. Soluble salts occur on this unit as a product of weathering of **Km**. **Paleontological Resources**—unit has the potential to yield micropaleontological resources such as pollen.	**Disturbed Land Restoration**—Sand and gravel resources in units such as **Qpg** are extracted from local quarries adjacent to the monument. One abandoned pit is located southwest of the monument and an access road is still in the process of being restored. **Springs and Seeps**—Unconsolidated gravels permit the flow of groundwater to emerge as seeps and springs in the monument. Springs emerging from surficial deposits tend to be less mineralized than those emerging from **Km**. **Surficial Features and Processes**—Pediment surfaces are associated with erosional areas of the landscape.	**Cenozoic Era**—**Qpg** and **Qsw** reflect active processes of erosion and weathering on the monument's landscape. The coarsest elements of these units are left as remnants whereas the finer grains wash away during infrequent storms.
	Slope wash (Qsw)	The slope wash unit consists of a mix of colluvium, talus, and landslide deposits all of which form as accumulations of materials that fell, slid, or rolled downslope after being dislodged above. Individual blocks tend to be angular and may contribute to the formation of irregular, hummocky topography. *Note*: Slope wash (Qsw) is a grouped unit using a different source map from the talus (Qt) and landslide (Ql) units defined on this table as separate units. Slope wash is a mixture of material deposited by mass wasting and unconfined overland flow (M. Gillam, geologist, written communication, 14 May 2013).	**Connections between Geology and Park Stories**—Groundwater flowing through this unit off the slopes of Sleeping Ute Mountain emerges as springs such as those in the monument. The ancestral Puebloan people focused settlements around these springs. Soluble salts occur on this unit as a product of weathering of **Km**.	**Disturbed Land Restoration**—Sand and gravel resources in units such as **Qsw** may be extracted from local quarries. **Springs and Seeps**—Unconsolidated gravels permit the flow of groundwater to emerge as seeps and springs in the monument. Springs emerging from surficial deposits tend to be less mineralized than those emerging from **Km**. **Surficial Features and Processes**—Slope wash processes could impact archeological resources in the northern reaches of the monument.	
TERTIARY-CRETACEOUS	Diorite porphyry (TKdp)	**TKdp** is a medium gray, diorite porphyry with visibly large crystals (phenocrysts) of hornblende (dark-colored) and andesine (light-colored) in a fine-grained matrix. The term diorite refers to an igneous rock with intermediate silica contents. This unit locally intruded the surrounding sedimentary rocks to form laccoliths—intrusions that form between sedimentary layers and frequently form a convex-up dome.	**Connections between Geology and Park Stories**—Diorite boulders (washed from Sleeping Ute Mountain) were among the building materials used by the ancestral Puebloan people. Igneous rocks such as **TKdp** are also found as hammer stones and other artifacts.	**Slope Movements**—Resistant boulders of **TKdp** frequently litter the landscape as less resistant material is eroded away.	**Cenozoic Era**—**TKdp** formed at a time when igneous activity was widespread across the area.
CRETACEOUS	Cliff House Sandstone (Kch)	**Kch** consists of grayish orange, very fine- to fine-grained sandstone. Cross-beds are common in this unit. Relatively soft shaly sandstone and siltstone layers separate massive sandstones. Maximum thickness of **Kch** is locally 122 m (400 ft).	**Connections between Geology and Park Stories**—Blocks of **Kch** were used as building stones in Mesa Verde National Park and in the Ute Mountain Tribal Park, but not recognized at Yucca House. Weathering of less resistant units between the massive sandstones of **Kch** forms alcoves between the cliffs that are commonly occupied by ancient cliff dwellings in the Mesa Verde area. **Kch** crops out at Mesa Verde. **Kch** forms prominent cliffs in the area. **Paleontological Resources**—**Kch** contains *Ophiomorpha* burrows and *Inoceramus*-filled troughs. In the Mesa Verde National Park area, **Kch** contains ammonites, bivalves, and a starfish impression.	**Slope Movements**—Resistant units such as **Kch** tend to form cliffs and are prone to rockfall. **Energy Development**—Bedrock is regionally explored for oil and gas potential.	**Mesozoic Era**—**Kch** was deposited in an advancing seaway as part of a lower to upper shoreface zone of a barrier-island beach front. It is analogous to the modern barrier islands at Cape Hatteras, North Carolina.

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Age	Map Unit (Symbol)	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
CRETACEOUS	Menefee Formation (Kme)	**Kme** consists of shale, carbonaceous (organic rich) shale, coal beds, siltstone, and lenticular sandstone beds. The shales are generally dark gray; the carbonaceous shale and coal are brown; the siltstone and sandstone are gray to grayish orange. **Kme** is locally 103 m (340 ft) thick.	**Connections between Geology and Park Stories**—Jet, or hard, polishable coal, from **Kme** was used by the ancestral Puebloan people at Mesa Verde. Red, burnt shale (clinker) results as a coal bed burns in situ. Pendants made from this type of rock feature in the Yucca House archaeological collection. **Kme** contains some prominent layers of clinker in the area. **Kme** crops out at Mesa Verde. **Paleontological Resources**—In the Mesa Verde National Park area, **Kme** contains scant bivalves, and some plant fossils and palynomorphs.	**Energy Development**—Bedrock is regionally explored for oil and gas potential.	**Mesozoic Era**—**Kme** was deposited on land of a low-relief former sea bottom as streams meandered across the area. This setting as analogous to a delta plain where the sandstone represents channels in a floodplain. Shales and coal beds formed near the marine shoreline. At this point in geologic time, the marine shoreline had regressed to its maximum extent and would readvance (transgress) to deposit **Kch**.
CRETACEOUS	Point Lookout Formation (Kpl)	In the Mesa Verde area, **Kpl** has a lower sandstone and interlayered shale member capped by a massive sandstone member. The interbedded yellowish-gray sandstone and dark olive gray, fossiliferous shale contrasts with the gray, fine- to medium-grained sandstone of the upper member. The combined thickness of **Kpl** is approximately 124 m (375 ft) locally.	**Connections between Geology and Park Stories**—**Kpl** may have been used by ancestral Puebloan people for building material; further excavation may reveal this at Yucca House. **Kpl** crops out at Mesa Verde. **Paleontological Resources**—In the Mesa Verde National Park area, **Kpl** contains trace fossils, bivalves, cephalopods, gastropods, shark teeth, wood, and coal.	**Slope Movements**—Resistant units such as **Kpl** tend to form cliffs and are prone to rockfall. **Energy Development**—Bedrock is regionally explored for oil and gas potential.	**Mesozoic Era**—**Kpl** records a regressive interval in the sedimentary history, deposited as shore face and strand plain sands. The deposition of **Kpl** was continuous after **Km** in a variety of coastal and shoreline environments. It represents an overall regression of the shoreline.
CRETACEOUS	Mancos Shale: Undifferentiated (Km); Cortez Member (Kmc); Smoky Hill Member (Kms); Montezuma Valley Member (Kmv); Juana Lopez Member (Kmj); Lower Mancos (Kmlm)	Locally, the Mancos Formation is gray to black shaly mudstone. The shaly mudstones are soft and fissile; the layers break apart easily. At nearby Mesa Verde National Park, **Km** is 610 m (2,000 ft) thick. Within undifferentiated **Km** are **Kmc**, **Kms**, **Kmv**, **Kmj**, and **Kmlm**. **Kms** and **Kmj** are both medium- to coarse-grained glauconitic (green-colored mica mineral) sandstone and sandy fossiliferous limestone (calcarenite). Mudstone interlayers are common in **Kmj**. These two members form prominent ledges in the lower 150 m (500 ft) of **Km**. **Kmlm** is gray to dark gray shale. **Kmv** is also predominantly gray shale. **Km** (surficial map) and **Kmj** (bedrock map) are mapped within Yucca House National Monument.	**Connections between Geology and Park Stories**—calcarenite beds from **Kmj** fracture naturally into building blocks and were used in the construction of the structures in the monument. Because of the low dip of 3° to 5° for **Kmj**, it is exposed over a large surface area locally, maximizing its availability to the ancestral Puebloan people to use in construction. **Kmj** frequently forms low terraces and irregular hills. The calcarenite in **Kmj** underlies long, low ridges trending northeast to southwest. **Km** weathers to produce clay-rich soils that support the dessert scrub plant cover. **Paleontological Resources**—**Kmj** contains ammonites (*Baculites undulates*, B. yokoyami*, Prionocyclus macombi, P. wyomingensis*, P. novimexicanus*, P. quadratus, Scaphites warreni*,* and *S. whitfieldi**); bivalves (*Inoceramus dimidius*, I. perplexus*,* and *Nicaisolopha* (or *Lopha*) *lugubris*,* mollusks, gastropods, chondrichthyans, skate teeth, fish bones and scales. An arm bone from the toothed bird *Ichthyornis* found regionally. Ammonites and bivalves in **Kmj** make up four successive taxonomic zones. **Kmv** and **Kms** contain foraminifera, ammonites, brachiopods, bivalves, and plants locally. Oyster benches of *Inoceramus (Volviceramus) grandis* and encrusting bivalve *Pseudoperna congesta* are distinctive in **Kms**. **Kmj** is suspected to contain plesiosaur remains locally. **Indicates fossils in Mancos Shale known to occur within Yucca House National Monument.*	**Springs and Seeps**—Groundwater percolates through some of **Km** prior to emerging as springs. Springs emerging from bedrock tend to be highly mineralized and not very palatable. **Swelling Clays**—Shrink-and-swell clays in the Mancos Shale may cause damage to future infrastructure if not properly identified, located, and avoided. **Slope Movements**—Resistant units such as **Kms** and **Kmj** tend to form ledges and are prone to rockfall. **Future Park Development**—Significant outcrops of **Kmj** occur 800 m (0.5 mi) west and southwest of the current monument boundary. Infrastructure proposed on outcrops of **Km** or soils developed on this unit should take into account the possibility of shrink-and-swell clays.	**Mesozoic Era**—Mancos Shale conformably overlies Dakota Sandstone (**Kd),** marking continuous-deposition and no erosion between the two units. Within the members of the Mancos Shale is the record of at least four marine transgression–regression cycles over 13 million years. Calcareous (calcium carbonate) beds indicated an increasing distance from a transgressing (advancing) shoreline. **Km** grades upwards and interlayers with formations of the Mesa Verde Group (see **Kpl**, **Kme**, and **Kch**). **Km** thickens northeastward, possibly towards a center of deposition.

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Age	Map Unit (Symbol)	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
CRETACEOUS	Dakota Sandstone (Kd)	**Kd** consists of yellowish sandstone and coarser-grained conglomerate. Interlayered with these two rock types are carbonaceous (carbon-rich) shale and impure coal. Cross-beds within this unit are locally discontinuous and/or truncated lending it a lenticular character. **Kd** locally averages about 38 m (125 ft) in thickness.	**Connections between Geology and Park Stories**—**Kd** may have been used by ancestral Puebloan people for building material; further excavation may reveal this at Yucca House. **Kd** often provides ridgetop habitats and cliffs. **Paleontological Resources**—**Kd** contains ammonite fossils that were used to determine the approximate shoreline positions of the Western Interior Seaway. Regionally, it contains trace fossils, bivalves, cephalopods, gastropods, arthropods, echinoderms, plant debris, coal, ferns, gymnosperms, and angiosperms.	**Slope Movements**—Resistant units such as **Kd** tend to form cliffs or ridges and are prone to rockfall. **Energy Development**—Bedrock is regionally explored for oil and gas potential.	**Mesozoic Era**—**Kd** was deposited in shallow water, in lagoons and near the shore of a transgressing (advancing) sea. It records the first major incursion of sea water into the area by the Western Interior Seaway. An incised drainage surface locally separates **Kd** from underlying **Kbc**. This indicates a prolonged period of erosion.
CRETACEOUS	Burro Canyon Formation (Kbc)	**Kbc** consists of sandstone and coarser-grained conglomerate. Interlayered with these two rock types are green and red shale beds. **Kbc** locally ranges from 9 to 60 m (30 to 200 ft) in thickness.	**Connections between Geology and Park Stories**—Chert in algal limestone of **Kbc** was used for stone tools. **Paleontological Resources**—**Kbc** contains palynomorphs useful in dating the unit.	**Slope Movements**—Resistant units such as **Kbc** tend to form cliffs and are prone to rockfall. **Energy Development**—Bedrock is regionally explored for oil and gas potential.	**Mesozoic Era**—**Kbc** intertongues with the mudstone of **Jmb**, where one unit disappears laterally after splitting into many thin layers or tongues, each of which pinches out independently.
JURASSIC	Morrison Formation: Brushy Basin Shale Member (Jmb)	**Jmb** is multicolored mudstone with lenses of coarse-grained, conglomeratic sandstone. **Jmb** is 45 to 90 m (150 to 300 ft) thick.	**Connections between Geology and Park Stories**—**Jms** is uranium bearing in many areas of the Colorado Plateau, but not locally. **Paleontological Resources**—The Morrison Formation is elsewhere famous for vast deposits of dinosaur fossils, such as those at Dinosaur National Monument.	**Swelling Clays**—The mudstone is particularly rich in bentonite, a shrink-and-swell clay derived from weathered volcanic ash. Bentonitic layers in **Jmb** can pose a problem for infrastructure development. Roads in nearby Mesa Verde National Park have required significant maintenance because of shrink-and-swell clays. **Slope Movements**—Resistant units such as **Jmw** tend to form ledges and are prone to rockfall. **Energy Development**—Bedrock is regionally explored for oil and gas potential.	**Mesozoic Era**—**Jmb**, **Jmw**, and **Jms** intergrade with each other. Locally, the contacts between the members are arbitrary indicating more or less constant deposition at this time in the Jurassic Era. The Morrison Formation was deposited in the largest and oldest known playa-lake complex in the world.
JURASSIC	Morrison Formation: Westwater Canyon Sandstone Member (Jmw)	**Jmw** consists of pale yellowish brown, fine- to medium-grained sandstone. The sandstone is interlayered with green mudstones. Similar to **Jmb**, the mudstones in **Jmw** are rich in shrink-and-swell bentonite clay. **Jmb** is 23 to 30 m (75 to 100 ft) thick.			
JURASSIC	Morrison Formation: Salt Wash Sandstone Member (Jms)	**Jms** contains tannish gray, fine- to medium-grained sandstone. The sandstone is locally interlayered with reddish brown and purple mudstone. **Jms** is 45 to 75 m (150 to 250 ft) thick.			
JURASSIC	Junction Creek Sandstone (Jjc)	Locally, **Jjc** contains three units that grade into each other (i.e. lack sharp boundaries). <u>The upper unit</u> is reddish, fine-grained, argillaceous (mud-rich) sandstone. Layering within the upper unit is flat and obscure from a depositional setting standpoint. <u>The middle unit</u> is pink to orange-red, fine- to coarse-grained sandstone with a jumble of grainsizes (poorly sorted). It contains highly angular stratification (layering) within this unit and it weathers to produce a "slick rim." <u>The lowermost unit</u> is similar in composition to the middle unit, but the angle of the stratification to the horizontal is lower and has numerous prominent horizontal truncations. The combined thickness of **Jjc** is 70 to 85 m (230 to 280 ft).	**Connections between Geology and Park Stories**—Regionally, the massive sandstones of the Jurassic units form steep cliffs and canyons. **Paleontological Resources**—Vertebrate trace fossils are more common in **Jn** and **Je** than body fossils. Regionally, fossils within **Js** include plant debris and a variety of vertebrate tracks.	**Slope Movements**—Resistant units such as **Jjc** tend to form cliffs or ledges and are prone to rockfall. **Energy Development**—Bedrock is regionally explored for oil and gas potential.	**Mesozoic Era**—The contact between **Js** and **Jjc** is gradational indicating a relatively continuous period of deposition at this point in the Jurassic Period. **Jjc** grading upward into the Morrison Formation signals the formation of a back arc rift basin.
JURASSIC	Summerville Formation (Js)	**Js** consists of 37–40 m (120–130 ft) of brick-red mudstone and pink to reddish-brown, well-sorted sandstone. The texture of the sandstone is fine-grained and its composition is somewhat argillaceous (mud-rich).		**Slope Movements**—Resistant sandstone layers in **Js** tend to form ledges and are prone to rockfall. **Energy Development**—Bedrock is regionally explored for oil and gas potential.	**Mesozoic Era**—Regionally, the contact between **Je** and **Js** can be gradational or marked by an unconformity (period of erosion or non-deposition). **Js** marks the incursion of marginal marine and tidal depositional environments atop the sand dune seas (ergs) of **Je** and **Jn**.

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Age	Map Unit (Symbol)	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
JURASSIC	Entrada Sandstone (Je)	**Je** locally consists of two subunits. The upper unit is pale brown and light pink sandstone that grades downward to white and orange-red sandstone. It is 21 to 24 m (70 to 80 ft) thick and weathers to produce a "slick rim." The lower unit is very fine-grained, brick-red sandstone. It is 8 to 11 m (25 to 35 ft) thick and somewhat argillaceous (mud-rich).	**Connections between Geology and Park Stories**—Regionally, the massive sandstones of the Jurassic units form steep cliffs and canyons. **Paleontological Resources**—Vertebrate trace fossils are more common in **Jn** and **Je** than body fossils. Regionally, fossils within **Js** include plant debris and a variety of vertebrate tracks.	**Slope Movements**—Resistant units such as **Je** tend to form cliffs and are prone to rockfall. **Energy Development**—Bedrock is regionally explored for oil and gas potential.	**Mesozoic Era**—**Je** was deposited in a semiarid to arid dune field, the last major erg (sand sea) of the area.
	Navajo Sandstone (Jn)	**Jn** is sandstone that appears orange-colored in outcrop and contains numerous prominent horizontal truncations where sedimentary structures such as cross-beds are cut off.		**Slope Movements**—Resistant units such as **Jn** tend to form cliffs and are prone to rockfall. **Energy Development**—Bedrock is regionally explored for oil and gas potential.	**Mesozoic Era**—The sand collected in massive aeolian (wind-blown) dunes to later solidify as sandstone. **Jn** was part of the largest erg known from North America.