GEOLOGIC MAP OF THE DONKEY FLAT QUADRANGLE, UINTAH COUNTY, UTAH

by Paul H. Jensen, Douglas A. Sprinkel, Bart J. Kowallis, and Kent D. Brown

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by Paul H. Jensen [1], Douglas A. Sprinkel [2], Bart J. Kowallis [1], and Kent D. Brown [2]

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SCALE: 1:24,000

Cover photo: *The Red Fleet, a set of geomorphic features that resemble a fleet of battleships plying the sea, is formed by the differential erosion of the Triassic Chinle Formation and the Triassic-Jurassic Nugget Sandstone. The Red Fleet is located north of Red Fleet State Park, Uintah County. View to the east.*

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GEOLOGIC MAP OF THE DONKEY FLAT QUADRANGLE, UINTAH COUNTY, UTAH

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OVERVIEW

The Donkey Flat quadrangle is less than 10 miles north-northeast of Vernal, Utah, along the south flank of the Uinta Mountains in Uintah County. It includes Red Fleet State Park, a popular recreational area, and is crossed by U.S. Highway 191, which is designated as a National Scenic Byway.

The geology is well exposed and relatively uncomplicated within the quadrangle, making a dramatic landscape with thick sandstone cliffs and varicolored to drab gray slopes. The quadrangle contains a variety of unconsolidated deposits of Holocene and Pleistocene age that range from stream alluvium to piedmont gravel to eolian sand. The quadrangle's namesake is one of several geomorphic surfaces mantled by piedmont gravel deposits. Bedrock generally dips southward; the Permian-Pennsylvanian Weber Sandstone exposed in the northwest part of the quadrangle is the oldest bedrock formation, and the Upper Cretaceous Mancos Shale is the youngest bedrock unit and dominates the southern half of the quadrangle. Dips range from about 5° to 30° and decrease southward, reflecting the structural influence of the Island Park syncline mapped in the southeast part of the quadrangle. We also mapped minor folds within the Mancos Shale in the southwest part of the quadrangle, and some of the anticlines were targets for oil and gas exploration. No faults were mapped within the quadrangle.

Of special stratigraphic note, we have applied the informal name "formation of Bell Springs" to the map unit that lies between the overlying Nugget Sandstone and the underlying Chinle Formation. This lithostratigraphic unit has been previously recognized and described in the Uinta Mountain area (Thomas and Krueger, 1946; Kinney, 1950; Sikich, 1960; Poole and Stewart, 1964; Sikich, 1965; High and Picard, 1967; High and others, 1969; Picard, 1975; Lucas, 1993; Jensen and Kowallis, 2005; Sprinkel and others, 2011b; Irmis and others, 2015) with various names and ranks. Thomas and Krueger (1946) placed these strata, as well as the underlying Chinle Formation, into a new formation they called the Stanaker Formation with a type section within the Donkey Flat quadrangle "measured north of Vernal, Uintah County, Utah, from section 7, T. 3. S., R. 22 E., SLB&M, northward to a tributary of Brush Creek near the northwest corner of section 32, T. 2 S., R. 22. E., SLB&M, and west of the Vernal-Manila highway" (U.S. Highway 191). Sikich (1960, 1965) measured additional sections of the Stanaker Formation within the Donkey Flat quadrangle. In all of these measured sections, approximately the upper 100 feet of the Stanaker Formation is equivalent to the formation of Bell Springs as defined here. The Stanaker Formation as defined by these authors never came into general usage with other workers in the area who continued to use terminology from either the Colorado Plateau or from Wyoming. Lucas (1993) elevated this interval from a member to a formation of the Chinle Group in the Uinta Mountain region. We have chosen to use the informal name (formation of Bell Springs) because we have not fully evaluated the regional correlation with other current and former names and their stratigraphic ranking. The formation of Bell Springs is conformable with the overlying Nugget Sandstone and is unconformable with the underlying Chinle Formation. The unconformity is thought to be regional by some stratigraphers, separating correlative units in Wyoming, southeastern Idaho, northern Utah, and on the Colorado Plateau (High and Picard, 1967; Pipiringos, 1968; High and others, 1969; Picard, 1975; Lucas, 1993; Lucas and others, 1997). However, the unconformity may be local in the eastern Uinta Mountains (Poole and Stewart, 1964; Jensen and Kowallis, 2005; Sprinkel and others, 2011b). Age of the Bell Springs is Rhaetian (Late Triassic), constrained by aetosaur tracks in the lower part of the overlying Nugget Sandstone (Lockley and others, 1992; Lockley, 2011; Sprinkel and others, 2011b), by palynological data (Irmis and others, 2015), and by isotopic dating (U-Pb zircon) of correlative underlying strata of the Chinle Formation in Arizona (Ramezani and others, 2011).

Geologic resource development within the quadrangle includes active phosphate mining associated with the Park City Formation, and a sand and gravel pit associated with piedmont gravel deposits. Other geologic resources that have been explored include oil and gas in the Buckskin Hills area and minor coal deposits in the Frontier Formation. Three unsuccessful oil and gas exploration drill holes are located in the southwest part of the quadrangle (plate 1). The deepest drill hole was drilled by Cities Services Company/McAdams (table 1). The Brush Creek 1 (A-3; API 4304710702; SESE section 30, T. 3 S., R. 22 E., SLB&M) drilled to 5522 feet and reached the Weber Sandstone. No shows or tests were reported by the operator. The other two drill holes drilled less than 5000 feet of section in which the Promontory Oil Company Buckskin Hills 19-1 (A-1; API 4304710937; SWNW section 19, T. 3 S., R. 22 E., SLB&M) reached the Moenkopi Formation and the Sunray

Table 1. Formation tops from wells drilled in the Donkey Flat 7.5-munte quadrangle.

ID Label	Well Information	Formation	Map Unit Symbol	Top (feet)	Thickness (feet)	Elevation (feet)	Top (meters)	Thickness (meters)	Elevation (meters)	Comments
A-1	Promontory Oil	Mancos Shale	Kms	0	1905	5636	0	581	1718	Kelly Bushing elevation
	Buckskins Hills 19-1	Frontier Formation	Kf	1905	165	3731	581	50	1137	
	SW1/4NW1/4 Section 19, T. 3 S., R. 22 E.	Mowry Shale	Km	2070	135	3566	631	41	1087	
	Salt Lake Base & Meridian	Dakota Formation	Kd	2205	167	3431	672	51	1046	
	Uintah County, Utah	Cedar Mountain Formation	Kc	2372	104	3264	723	32	995	
	API: 4304710937	Morrison Formation	Jm	2476	724	3160	755	221	963	
	Wildcat	Stump Formation	Js	3200	212	2436	975	65	742	
	Plugged and Abandoned	Entrada Sandstone	Je	3412	76	2224	1040	23	678	
		Carmel Formation	Jc	3488	236	2148	1063	72	655	
		Nugget Sandstone	JTRn	3724	496	1912	1135	151	583	
		formation of Bell Springs	TRb	4220	90	1416	1286	27	432	estimated top from map and regional thickness
		Chinle Formation	TRc	4310	150	1326	1314	46	404	estimated top from map and regional thickness
		Moenkopi Formation	TRm	4460	360	1176	1359	110	358	estimated top from map and regional thickness
		Total Depth		4820		816	1469		249	
A-2	Sunray DX Oil Company	Mancos Shale	Kms	0	3090	6111	0	942	1863	Drilling Floor elevation
	Utah Fed E-1	Forntier Formation	Kf	3090	112	3021	942	34	921	
	SE1/4SE1/4 Section 28, T. 3 S., R. 22 E.	Mowry Shale	Km	3202	518	2909	976	158	887	
	Salt Lake Base & Meridian	Dakota Formation	Kd	3720	120	2391	1134	37	729	
	Uintah County, Utah	Cedar Mountain Formation	Kc	3840	99	2271	1170	30	692	
	API: 4304711177	Total Depth		3939		2172	1201		662	
	Wildcat									
	Plugged and Abandoned									
A-3	J.F. McAdams	Mancos Shale	Kms	0	1660	5783	0	506	1763	Kelly Bushing elevation
	Brush Creek Unit #1	Frontier Formation	Kf	1660	140	4123	506	43	1257	
	SE1/4SE1/4 Section 30, T. 3 S., R. 22 E.	Mowry Shale	Km	1800	420	3983	549	128	1214	
	Salt Lake Base & Meridian	Dakota Formation	Kd	2220	115	3563	677	35	1086	
	Uintah County, Utah	Cedar Mountain Formation	Kc	2335	75	3448	712	23	1051	
	API: 4304710702	Morrison Formation	Jm	2410	460	3373	735	140	1028	
	Wildcat	Stump Formation	Js	2870	165	2913	875	50	888	
	Plugged and Abandoned	Entrada Sandstone	Je	3035	215	2748	925	66	838	
		Carmel Formation	Jc	3250	108	2533	991	33	772	
		Nugget Sandstone	JTRn	3358	876	2425	1024	267	739	
		formation of Bell Springs	TRb	4234	116	1549	1291	35	472	
		Chinle Formation	TRc	4350	105	1433	1326	32	437	
		Moenkopi Formation	TRm	4455	478	1328	1358	146	405	
		Dinwoody Formation	TRd	4933	377	850	1504	115	259	
		Park City Formation	Pp	5310	170	473	1618	52	144	
		Weber Sandstone	PlPw	5480	42	303	1670	13	92	
		Total Depth		5522		261	1683		80	

DX Oil Company Utah Federal E-1 (A-2; API 4304711177; SESE section 28, T. 3 S., R. 22 E., SLB&M) reached the Frontier Formation. Only the Buckskin Hills 19-1 drill hole (A-1) had oil shows; the operator reported testing oil from the Curtis Member of the Stump Formation, but the drill hole was eventually plugged and abandoned. No producing wells or coal mines are within the quadrangle to date.

Some of the geologic highlights in the quadrangle include the well-developed piedmont and terraces near and along Brush Creek. Invertebrate fossils were found in most of the formations and permineralized wood was found in the Dakota and Morrison Formations and the Gartra Member of the Chinle Formation. Dinosaur tracks can be observed along the north shore of Red Fleet Reservoir in the upper part of the Nugget Sandstone (Hamblin and Bilbey, 1999; Hamblin and others, 2000). A trail that leads to the track site begins near the base of the Nugget Sandstone and winds up section through excellent exposures of the large-scale eolian cross-beds.

DESCRIPTION OF MAP UNITS

Quaternary Surficial Map Units

Boundary age for Quaternary series shown in the correlation of surficial units are from Cohen and others (2013).

Human-Modified Deposits

Qhd **Red Fleet Reservoir dam** (Historical) – Dam embankment fill consisting of clay, silt, sand, gravel, and boulders of Paleozoic and Neoproterozoic clasts from local piedmont gravel deposits.

Qhm **Phosphate strip mine** (Historical) – Local surficial deposits and the Park City Formation modified to such a degree that the original bedding is no longer expressed in areas where mining is active; inactive parts of the mine are reclaimed with fill and seeded with native vegetation (see below for formation descriptions); bedrock configuration in the unmined areas within the mine property may change over time as mining continues; variable thickness.

Qhml **Mine tailing pond** (Historical) – Area where mine tailings are stored; includes impoundment structure; covers Triassic Moenkopi and Dinwoody Formation (see below for formation descriptions); as much as 150 feet deep.

Alluvial Deposits

Qal_1 **Youngest stream alluvium** (Holocene) – Unconsolidated silt, sand, gravel, and cobbles in active channels of perennial and intermittent creeks; commonly stratified; fine-grained material generally derived from locally weathered formations; may contain cobbles and boulders from formations exposed upstream; less than 30 feet thick.

Qal_2 **Older stream alluvium** (Holocene) – Unconsolidated silt, sand, gravel, and cobbles 40 to 50 feet above Big and Little Brush Creek, Brush Creek, Cottonwood Wash, and some of their tributaries; commonly stratified; fine-grained material generally derived from locally weathered formations; may contain cobbles and boulders from formations exposed upstream; less than 30 feet thick.

Qal_3 **Oldest stream alluvium** (Holocene) – Unconsolidated silt, sand, gravel, and cobbles 60 to 80 feet above Big and Little Brush Creek and Brush Creek; commonly stratified; fine-grained material generally derived from locally weathered formations; may contain cobbles and boulders from formations exposed upstream; less than 30 feet thick.

Qap_1 **Level 1 piedmont gravel** (Holocene[?] and Pleistocene) – Unconsolidated to poorly consolidated, pebble to boulder, clast-supported gravel; well-rounded to subrounded and moderately sorted; mixed mostly Neoproterozoic Uinta Mountain Group and subordinate Paleozoic (mostly carbonate) clasts; development of pedogenic calcium carbonate coating on underside of some clasts; gravel mantles pediment-like geomorphic surfaces and forms small gravel-capped mesas, like Donkey Flat, that are about 160 to 200 feet above Brush Creek; the surfaces generally slope south-southwest mostly between about 5600 and 5800 feet; graveled surfaces are local and not regional like Qap_2; 1 to 20 feet thick.

Qap_2 **Level 2 piedmont gravel** (upper Pleistocene) – Unconsolidated to moderately consolidated, pebble to boulder, clast-supported gravel; well-rounded and moderately sorted; mixed mostly Neoproterozoic Uinta Mountain Group and subordinate Paleozoic (mostly carbonate) clasts; development of pedogenic calcium carbonate varies from coating on underside of clasts to pervasive coating of clasts and matrix; gravel mantles pediment-like geomorphic surfaces and forms gravel-capped mesas that are about 300 to 500 feet above Brush Creek; the surfaces generally slope south-southwest mostly between about 6000 and 6200 feet; these graveled surfaces are more regional than Qap_1 and may represent a dissected regional surface along the lower slope of the Uinta Mountains; 5 to 50 feet thick.

Qap_3 **Level 3 piedmont gravel** (middle Pleistocene) – Unconsolidated to poorly consolidated, pebble to boulder, clast-supported gravel; well-rounded and moderately sorted; mixed mostly Neoproterozoic Uinta Mountain Group (90%), Paleozoic carbonate (7%), and Paleozoic sandstone (3%) clasts; development of pedogenic calcium carbonate varies from coating on underside of clasts to pervasive coating of clasts and matrix; U-series ages of 173 ± 4 ka to 187 ± 11 ka from innermost layer of calcium carbonate on clasts obtained from samples on the Diamond Mountain Plateau (north of the quadrangle) (Sprinkel and others, 2013); gravel mantles pediment-like geomorphic surfaces and forms the highest gravel cap on the Buckskin Hills that is 1100 to 1400 feet above Brush Creek; the surface generally slopes south-southwest mostly between about 6500 and 6800 feet in the quadrangle and between 7200 and 7500 feet on the Diamond Mountain Plateau; these graveled surfaces are found on the Diamond Mountain and Yampa Plateaus along the south flank of the Uinta Mountains, and on a few topographically high outliers within the Uinta Basin, suggesting a basin-wide deposit that represents a dissected regional mantled surface along the lower slope of the Uinta Mountains; less than 500 feet thick.

Qaf **Alluvial-fan deposits** (Holocene) – Unconsolidated mud, silt, sand, and gravel (cobbles to boulders); poorly sorted; may grade to stream alluvial deposits (Qal_1); forms typical fan-shape deposit at the mouths of drainages to broad coalescing deposits along the base of highlands that have several drainages along their length; less than 30 feet thick.

Colluvial Deposits

Qc **Colluvium** (Holocene and Pleistocene) – Unconsolidated sand and gravel with some silt and few cobbles deposited on slopes by gravity and locally derived from surficial map units and bedrock formations; less than 10 feet thick.

Qcg **Colluvial gravel** (Holocene and Pleistocene) – Unconsolidated gravel-dominated colluvium with some sand and silt deposited on slopes by gravity and derived locally from weathered piedmont gravel deposits; less than 10 feet thick.

Qcs **Colluvial sand** (Holocene and Pleistocene) – Unconsolidated sand-dominated colluvium with some silt and few cobbles deposited on slopes by gravity and locally derived from sand-rich surficial map units and sandstone bedrock formations; less than 10 feet thick.

Eolian Deposits

Qes **Eolian sand** (Holocene and upper Pleistocene) – Unconsolidated, well-sorted, fine- to medium-grained sand; forms small dunes or thin deposits that mound up on vegetation; may grade to Qecs deposits; derived from and deposited on the Nugget Sandstone; less than 10 feet thick.

Mass-Movement Deposits

Qms **Landslide deposits** (Holocene and Pleistocene) – Locally derived, mixed clay to boulders, bedrock, and blocks in rotational slumps, translational slides, and earth flows; commonly forms hummocky and irregular topography that includes closed depressions and sag ponds, internal scarps, and chaotic bedding attitudes; commonly formed in fine-grained and clay-rich bedrock units such as the Mancos, Mowry, Morrison, and Chinle Formations; landslides in the map area are commonly triggered by increased (and often rapid) soil moisture such as high-intensity rainfall events, above-normal precipitation, rapid snowmelt, or excessive irrigation; relative ages of mass-movement deposits to indicate recent versus older slides were not differentiated because research indicates that even landslides considered old and inactive actually may continue to move by slow creep, are capable of renewed movement, and pose a risk (Ashland, 2003); variable thickness.

Mixed-Environment Deposits

Qac **Mixed alluvium and colluvium, sand and silt deposits** (Holocene) – Unconsolidated, well- to moderately sorted, locally derived, mixed silt and fine-grained sand; minor coarser material may be present; generally deposited on Chinle, Carmel, Dakota, Mowry, and Frontier Formations, mostly around Red Fleet Reservoir, by both alluvial and colluvial processes; less than 10 feet thick.

Qacg **Mixed alluvium and colluvium, gravel-dominated deposits** (Holocene) – Unconsolidated gravel with some sand and silt derived from locally weathered Qap_2 deposits; deposited by both alluvial and colluvial processes; located along a drainage east of Little Brush Creek in section 31, T. 2 S., R. 23 E., SLB&M; less than 30 feet thick.

Qacs **Mixed alluvium and colluvium, sand-dominated deposits** (Holocene) – Unconsolidated, well- to moderately sorted, locally derived, mixed fine-grained sand and silt; generally deposited on Nugget Sandstone and Gartra Member of Chinle Formation by both alluvial and colluvial processes; less than 10 feet thick.

Qaci **Mixed alluvium and colluvium, silt-dominated deposits** (Holocene) – Unconsolidated, well- to moderately sorted, locally derived, mixed silt and fine-grained sand; generally deposited on fine-grained bedrock formations like the Morrison, Stump, and

Chinle Formations by both alluvial and colluvial processes; less than 10 feet thick.

Qecs **Mixed eolian sand and colluvium deposits** (Holocene) – Unconsolidated, well-sorted, mixed fine-grained sand and silt; may grade to Qes deposits; generally deposited on Nugget Sandstone by both eolian and colluvial processes; less than 10 feet thick.

Bedrock Units

Kms **Mancos Shale** (Upper Cretaceous, Campanian to Coniacian) – Shale, dark to medium gray; marine origin; little color and lithologic variability throughout; forms badlands topography; pediment deposits typically cap Mancos hills; oil and gas drill holes penetrated about 2000 to 3700 feet of Mancos Shale in the west and southwest part of the quadrangle but regionally is as much as 5000 feet thick.

Kf **Frontier Formation** (Upper Cretaceous, Turonian) –Sandstone, shale, and coal; formation can be divided into an upper cliff-forming sandstone and lower slope-forming shale; upper cliff-forming sandstone is light to moderate yellow brown, medium to coarse grained, thin bedded to massive, cliff and ledge forming; includes interval of medium- to dark-gray shale and coal; coal is dark gray to black, low-grade subbituminous, 6 to 9 feet thick, and preserved between two cliff-forming sandstone units in the upper part of the formation (Doelling and Graham, 1972); lower slope-forming shale includes an upper moderate-brown shale unit and lower medium-gray shale unit; formation contains large concretions (“cannonballs”) up to 6 feet in diameter mostly in the lower part of the cliff-forming sandstone; 125 to 230 feet thick.

Km **Mowry Shale** (Upper and Lower Cretaceous, Cenomanian to Albian) – Shale, bluish gray, interbedded with thin bentonitic ash beds; weathers characteristically in small, hard “chips”; contains abundant fish scales, fish bone, teeth, and coprolites (Anderson and Kowallis, 2005); marine origin; 110 to 140 feet thick.

Kd **Dakota Formation** (Lower Cretaceous, Albian) – Sandstone and shale, interbedded; sandstone is commonly light brown to yellowish gray, coarse grained with conglomerate lenses, limonite stained, and ledge to cliff forming; shale is dark gray, carbonaceous, and forms slope; typically upper and lower sandstone separated by carbonaceous shale; may include a thin basal dark-gray marine shale (Sprinkel and others, 2012); 125 to 300 feet thick.

Kcm **Cedar Mountain Formation** (Lower Cretaceous, Albian to Aptian) – Mudstone interbedded with carbonate, conglomerate, and minor sandstone lenses and beds; mudstone is pinkish gray, reddish brown, medium to very light gray, and grayish purple; contains calcic paleosols that weather to form limestone nodules; the formation also contains chert pebbles and gastroliths that commonly weather out; contains dinosaur fossils; slope forming; fluvial-lacustrine origin; 80 to 160 feet thick.

K-1 unconformity

Jm **Morrison Formation** (Upper Jurassic, Tithonian to Kimmeridgian) – Mudstone interbedded with sandstone, siltstone, and conglomerate that comprises four members; in descending order they are the Brushy Basin, Salt Wash, Tidwell, and Windy Hill Members; Brushy Basin Member (fluvial-lacustrine) is mudstone, mostly light gray in the upper part with a thin interval of variegated (grayish purple, grayish green, light gray, and pale pink hues) mudstone in the lower part, and slope forming; Salt Wash Member (fluvial) is a variegated interval of interbedded sandstone, conglomerate, siltstone, and silty mudstone; sandstone is very light brown, fine to medium grained, well sorted to moderately sorted, cross-bedded, and forms channels; conglomerate is pebble to cobble clast supported, poorly sorted, and cross-bedded; siltstone and silty mudstone is reddish brown to grayish green; sandstone and conglomerate beds are ledge forming; may include a basal sandstone that is light brown gray, fine to medium grained, well sorted, cross-bedded; Tidwell Member (tidal flat) is interbedded mudstone, siltstone, and sandstone; light gray to greenish gray with minor reddish brown; sandstone is very fine grained, rippled and cross-bedded; includes distinctive beds of light-red to pinkish amygdaloidal chert; Windy Hill Member (marine) is siltstone and sandstone, light gray to green gray; sandstone is thin bedded, rippled, cross-bedded, and glauconitic; the Windy Hill is restricted to northeastern Utah and is thought by some to rest unconformably (J-5) on the Stump Formation (Peterson, 1988; Turner and Peterson, 1999); however, others do not recognize an unconformity (Currie, 1997; Bilbey and others, 2005); we saw no clear evidence for an unconformity; 630 to 725 feet thick.

J-5 unconformity(?)

Js **Stump Formation** (Upper Jurassic, Oxfordian) – Sandstone and limestone interbedded with marine shale; limestone beds are light brown, sandy, oolitic, cross-bedded, and ledge forming; shale is olive brown, contains gypsum and belemnites; sandstone is very light gray, coarse grained, cross-stratified, contains glauconite, and is usually slope forming; 125 to 200 feet thick.

J-3 unconformity

Je **Entrada Sandstone** (Middle Jurassic, Callovian) – Two eolian sandstone beds bounded by terrestrial silt and mudstone beds; sandstone is very light gray and pale yellowish brown, medium grained, friable, commonly slope forming; mudstone is moderate reddish orange, slope forming; 200 to 250 feet thick.

Jc **Carmel Formation** (Middle Jurassic, Callovian to Bajocian) – Upper siltstone and lower limestone with gypsum, mudstone, and sandstone; siltstone is pale green, very light gray, and moderate reddish brown, fine grained, slope forming; limestone is medium gray, sandy, fossiliferous, with jasperized fossils, contains beds of altered volcanic ash; local and regional $^{40}Ar/^{39}Ar$ dating of sanidine and biotite crystals and U-Pb dating of zircon crystals yield ages between 166 and 168 Ma (Sprinkel and others, 2011a); 160 to 190 feet thick.

J-1 unconformity

JꞦn **Nugget Sandstone** (Lower Jurassic to Upper Triassic, Toarcian to Rhaetian) – Sandstone, light brown to light pinkish gray, medium to fine grained, massive weathering with large-scale high-angle cross-beds; forms cliffs, ledges, monoliths, arches, and spires; commonly jointed; weathers into loose sand commonly reworked by wind; predominantly eolian with thin fluvial lenses near base; also contains light brown to very light brown sandy dolomite and reddish brown siltstone of interdunal lacustrine origin typically 150 to 200 feet below top of formation; contains Early Jurassic dinosaur tracks in upper part and Late Triassic aetosaur tracks in the lower 30 feet of formation (Sprinkel and others, 2011b); 500 to 1140 feet thick.

Ꞧb **Formation of Bell Springs** (Upper Triassic, Rhaetian) – Sandstone, siltstone, and mudstone; mudstone is grayish red to moderate brown, often mottled with light-grayish-green reduction spots, locally has mudcracks and bioturbation; siltstone is moderate reddish orange to dark reddish brown, forming small (1–10 cm) ledges between mudstones; sandstone is very light gray to moderate reddish orange, fine to medium grained, ripple laminated to cross-bedded, locally with crinkly beds, salt casts, rip-up clasts, bioturbation and locally massive weathering; forms prominent ledges and slopes beneath the Nugget Sandstone within the quadrangle forming, what looks like, the bows of battleships locally called the Red Fleet, but becomes more slope forming eastward outside the quadrangle; predominantly fluvial-lacustrine with some eolian beds; 90 to 200 feet thick.

unconformity

Ꞧc **Chinle Formation, upper unnamed member** (Upper Triassic, Rhaetian[?] to Carnian) – Siltstone, mudstone, and sandstone interbedded with conglomerate and carbonate lenses; siltstone is moderate to dark reddish brown, fine grained, and slope forming; mudstone is grayish yellow, pale reddish purple, or variegated, fine-grained, ashy, and erodes to form badlands topography; sandstone is moderate reddish brown, fine grained, and very thin bedded; can be divided into an upper reddish unit dominated by moderate- to dark-reddish-brown siltstone, mudstone, and sandstone, a middle "ochre" unit dominated by grayish-yellow mudstone, and a lower mottled unit dominated by pale-reddish-purplish siltstone and mudstone; 105 to 230 feet thick.

Ꞧcg **Gartra Member of Chinle Formation** (Upper Triassic, Carnian) – Conglomerate and sandstone; conglomerate is very light gray with pebble-size clasts of mixed lithologies including chert and permineralized wood; sandstone is pale reddish brown to light gray, medium to coarse grained; forms cliffs; fluvial with channel-form base that cuts into underlying Moenkopi Formation; 15 to 100 feet thick.

Ꞧ-3 unconformity

Ꞧm **Moenkopi Formation** (Lower Triassic, Olenekian to Induan) – Siltstone and sandstone interbedded with gypsum; siltstone is moderate reddish orange, fine grained, ripple laminated, thinly bedded, and forms ledges and slopes; sandstone is moderate brown, fine grained, and massive, forms ledges at the top; locally interbedded with thin gypsiferous beds; gypsum is massive and forms a prominent ledge in the middle of the unit; marginal marine to fluvial; 550 to 1120 feet thick.

Ꞧd **Dinwoody Formation** (Lower Triassic, Induan) – Marine shale and gypsum interbedded with sandstone; shale is very light gray to light gray, forms slopes; sandstone beds are light gray, medium grained, micaceous, and form thin beds; 375 to 625 feet thick.

Ꞧ-1 unconformity

Pp **Park City Formation** (Middle to Lower Permian, Guadalupian to Cisuralian) – Dolomite beds interbedded with siltstone and shale of the upper Franson Member of the Park City Formation; dolomite beds are very light to medium gray, brownish gray, and dark greenish gray, glauconitic, sandy, and form prominent ledges; siltstone is reddish orange and forms a slope; the underlying Meade Peak Member of the Phosphoria Formation, which lies on the Weber Sandstone in the quadrangle, is dark-gray, marine shale, contains chert, and is mined for phosphate in the quadrangle; the lower Grandeur Member of the Park City Formation is missing within the quadrangle; 90 to 170 feet thick.

PlPw **Weber Sandstone** (Lower Permian to Middle Pennsylvanian, Artinskian[?] to Moscovian) – Sandstone, light gray to light brown, fine to medium grained; large-scale cross-bedding characterizes formation; lower part of formation contains sandstone and thin beds of limestone; lower sandstone is light brown, medium grained, glauconitic, cross-bedded; limestone is medium gray, thin bedded, and fossiliferous; forms massive-weathering cliffs; dominantly eolian with interbedded marine beds containing glauconite in lower part; locally contains large-scale fluid-escape structures; 1015 to 1275 feet thick.

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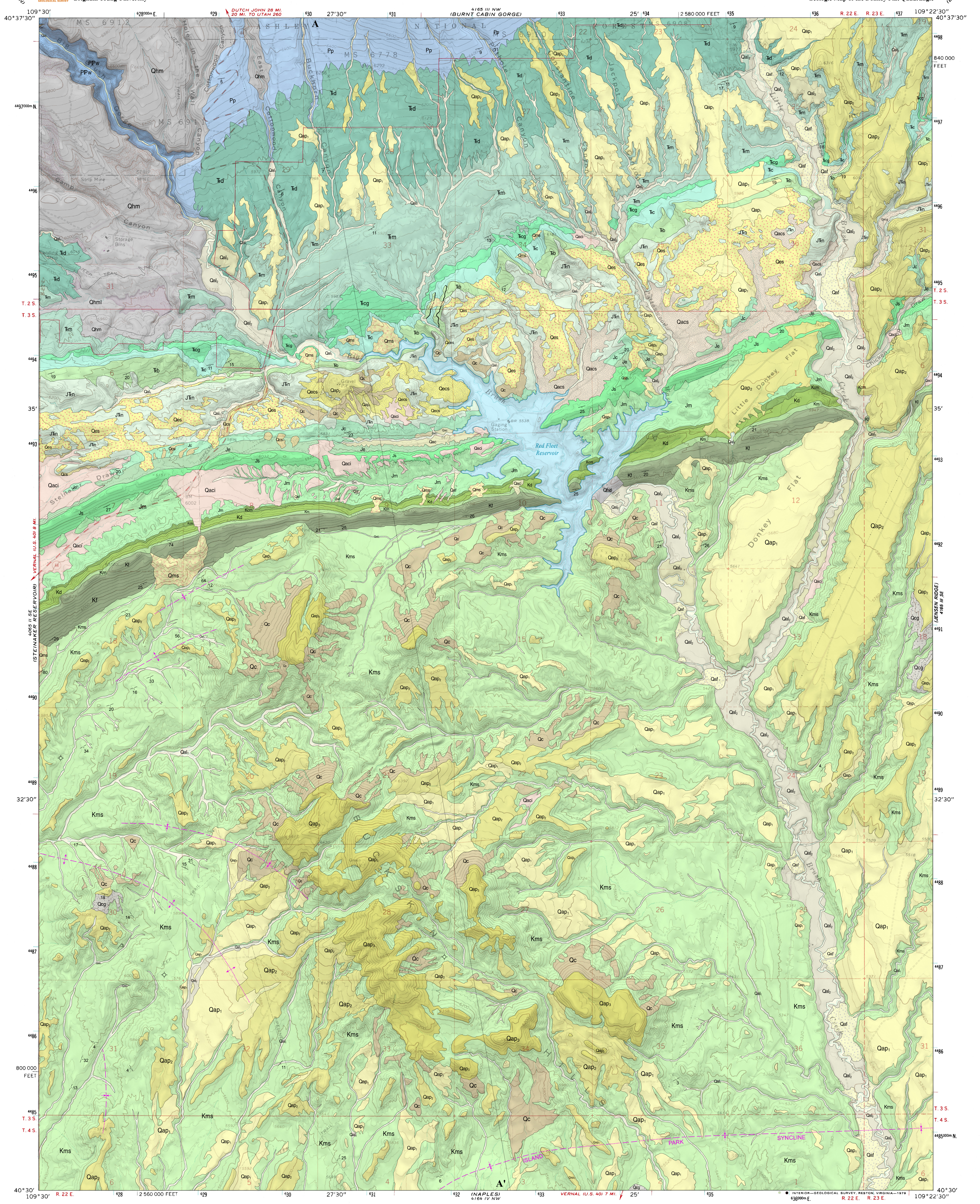
Plate 1
Utah Geological Survey Miscellaneous Publication 16-2DM
Geologic Map of the Donkey Flat Quadrangle



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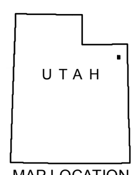
1 0.5 0 1 KILOMETER
CONTOUR INTERVAL 40 FEET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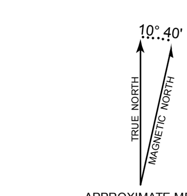
APPROXIMATE MEAN DECLINATION, 2015

GEOLOGIC MAP OF THE DONKEY FLAT QUADRANGLE, UINTAH COUNTY, UTAH

by
Paul H. Jensen[1], Douglas A. Sprinkel[2], Bart J. Kowallis[1], and Kent D. Brown[2]

2016

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Base from USGS Donkey Flat 7.5' Quadrangle (1979)
Shaded relief derived from
USGS 10 meter NED (National Elevation Dataset)
Projection: UTM Zone 12
Datum: NAD 1927
Spheroid: Clarke 1866

Project Manager: Douglas A. Sprinkel
Mapping by Paul H. Jensen (2004-2005), and Douglas A. Sprinkel (2012)
GIS and Cartography: Kent D. Brown

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This map was created from geographic information system (GIS) data

1	2	3
4		5
6	7	8

1. Dyer Mountain
2. Burnt Cabin Gorge
3. Blair Basin
4. Steinaker Reservoir
5. Jensen Ridge
6. Vernal NE
7. Naples
8. Dinosaur Quarry

ADJOINING 7.5' QUADRANGLE NAMES

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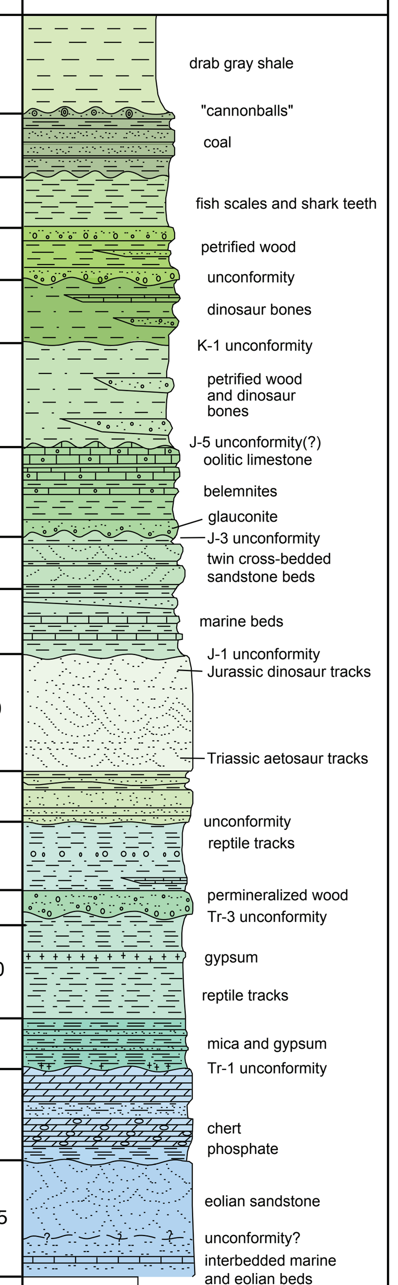
STRATIGRAPHIC COLUMN

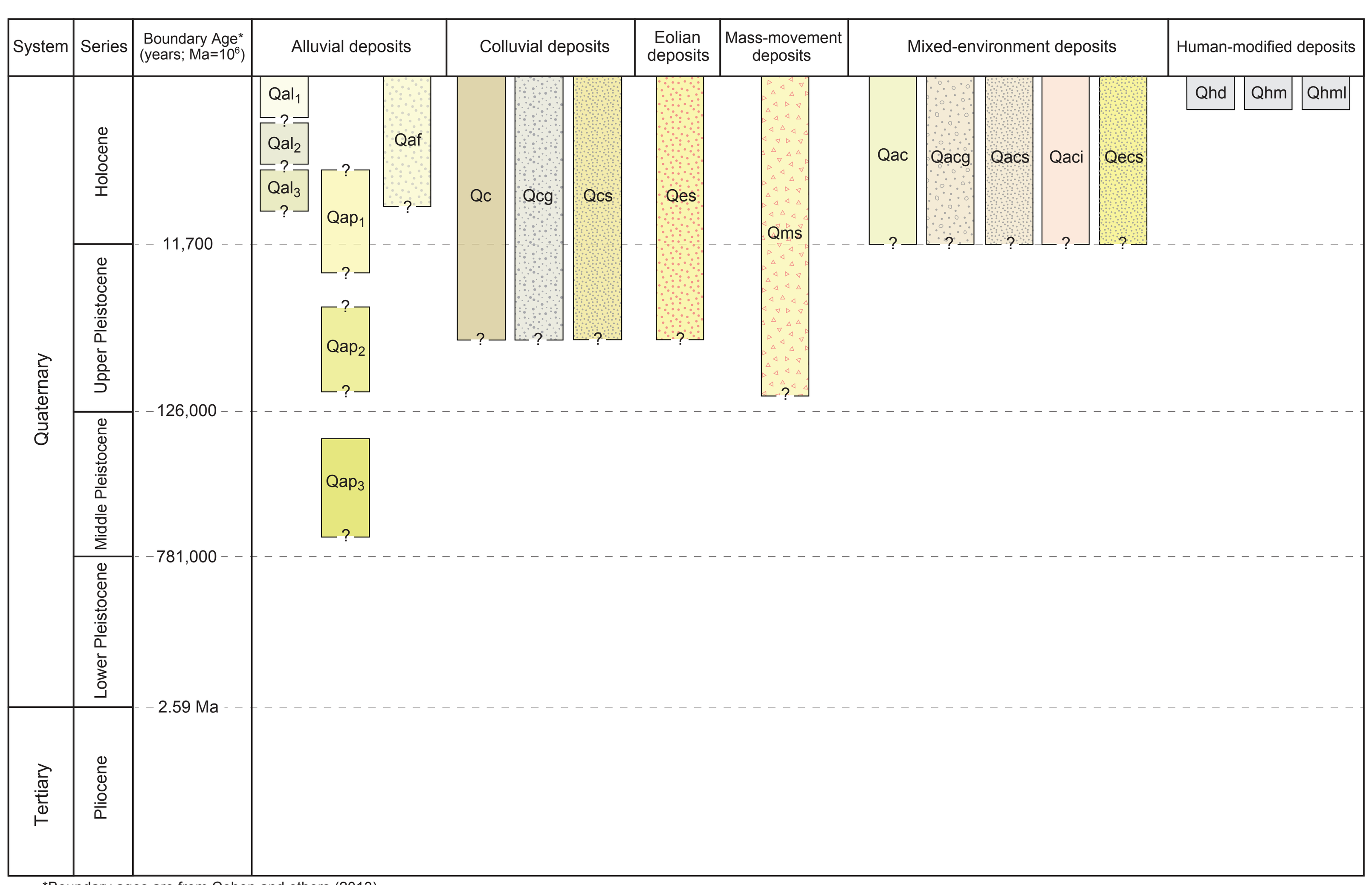
ERATHEM	SYSTEM	FORMATION		SYMBOL	THICKNESS feet	LITHOLOGY
MESOZOIC	CRETACEOUS	Mancos Shale		Kms	5000±	drab gray shale; "cannonballs"
		Frontier Formation		Kf	125–230	coal
		Mowry Shale		Km	110–140	fish scales and shark teeth
		Dakota Formation		Kd	125–300	petrified wood; unconformity
		Cedar Mountain Formation		Kcm	80–160	dinosaur bones; K-1 unconformity
	JURASSIC	Morrison Formation		Jm	630–725	petrified wood and dinosaur bones; J-5 unconformity(?)
		Stump Formation		Js	125–200	oolitic limestone; belemnites; glauconite; J-3 unconformity
		Entrada Sandstone		Je	200–250	twin cross-bedded sandstone beds
		Carmel Formation		Jc	160–190	marine beds; J-1 unconformity
		Nugget Sandstone		JTRn	500–1140	Jurassic dinosaur tracks; Triassic aetosaur tracks
	TRIASSIC	formation of Bell Springs		TRb	90–200	unconformity
		Chinle Formation	upper unnamed member	TRc	105–230	reptile tracks
			Gartra Member	TRcg	15–100	permineralized wood; Tr-3 unconformity
		Moenkopi Formation		TRm	550–1120	gypsum; reptile tracks
		Dinwoody Formation		TRd	375–625	mica and gypsum; Tr-1 unconformity
PALEOZOIC	PERMIAN	Park City Formation		Pp	90–170	chert; phosphate
	PENN	Weber Sandstone		IPPw	1015–1275	eolian sandstone; unconformity?; interbedded marine and eolian beds
		undivided (shown on cross section only)				
PRE-CAMBRIAN		undivided (shown on cross section only)				



MAP SYMBOLS

- Fault, unknown, dotted where concealed
- Formation contact
- A — A' Line of cross section
- Anticline; dashed where approximate and dotted where concealed
- Syncline; dashed where approximate and dotted where concealed
- 25 Strike and dip of inclined bedding (measured)
- 25 Strike and dip of inclined bedding (from photogrammetry)
- Plugged and abandoned drill hole
- Phosphate mine property line

CORRELATION OF SURFICIAL UNITS



*Boundary ages are from Cohen and others (2013)

CORRELATION OF BEDROCK UNITS

Q*	Holocene, Pleistocene	Quaternary
unconformity		
Kms	Upper	Cretaceous
Kf	Upper	Cretaceous
Km	Upper	Cretaceous
Kd	Lower	Cretaceous
Kcm	Lower	Cretaceous
K-1 unconformity		
Jm	Upper	Jurassic
J-5 unconformity(?)		
Js	Upper	Jurassic
J-3 unconformity		
Je	Middle	Jurassic
Jc	Middle	Jurassic
J-1 unconformity		
JTRn	Lower	Jurassic
TRb	Upper	Triassic
unconformity		
TRc	Upper	Triassic
TRcg	Upper	Triassic
Tr-1 unconformity		
TRm	Lower	Triassic
TRd	Lower	Triassic
unconformity		
Pp	Middle, Lower	Permian
IPPw	Upper, Middle	Pennsylvanian

Q* see correlation chart of surficial units