GEOLOGIC MAP OF THE SHORT CANYON QUADRANGLE, EMERY COUNTY, UTAH

by Hellmut H. Doelling and Paul A. Kuehne

MAP 255DM
UTAH GEOLOGICAL SURVEY
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UTAH DEPARTMENT OF NATURAL RESOURCES
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Cover photo: *View looking west across the brightly banded unit of the Brushy Basin Member of the Morrison Formation.*

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ABSTRACT

The Short Canyon quadrangle lies along the west edge of the Colorado Plateau physiographic province and the east edge of the High Plateaus, near a transition zone between the Colorado Plateau to the east and the Basin and Range Province to the west, and is in the Colorado River drainage basin. The west boundary is located about 5 miles (8 km) east of Emery, Utah, and about 40 miles (64 km) east of Salina, Utah. The south boundary is 2 to 3 miles (3–5 km) north of Interstate Highway 70.

Exposed bedrock ranges from Middle Jurassic to Late Cretaceous in age, includes (in ascending order) the Carmel Formation (part), Entrada Sandstone, Curtis Formation, Summerville Formation, Morrison Formation, Cedar Mountain Formation, Dakota Formation, and the Mancos Shale (part), and is about 3700 feet (1200 m) thick. The rocks of the quadrangle dip gently northwestward from the large San Rafael Swell anticline (to the southeast) into the Wasatch Plateau syncline (to the northwest). Quaternary surficial deposits of Holocene and Pleistocene age include varieties of alluvium, eolian, mass-movement, and mixed-environment deposits.

No mineral commodities are known to have been produced from the quadrangle area. Only thin coal deposits have been discovered in the Ferron Sandstone Member of the Mancos Shale and in the Dakota Formation.

INTRODUCTION

The Short Canyon quadrangle is located in Emery County in central Utah. The south boundary of the quadrangle is 2 to 3 miles (3–5 km) north of Interstate 70; the west boundary is 5 miles (8 km) east of the town of Emery and 40 miles (64 km) east of Salina, Utah. The quadrangle is named after Short Canyon, which flows into Dry Wash in the northern third of the quadrangle. The map area coincides with the west edge of the Colorado Plateau physiographic province and the east edge of the High Plateaus, a transition zone between the Colorado Plateau and Basin and Range Province. Emery and Moore are small towns in the southern part of Castle Valley, immediately west of the quadrangle.

The highest elevation on the quadrangle is along the Molen Reef in section 15, T. 22 S., R. 7 E. at 6930 feet (2113 m) and the lowest elevation is South Salt Wash along the south margin of the quadrangle in section 28, T. 22 S., R. 8 E., at 5720 feet (1743 m).

The principal access is a paved road that extends east from Moore to I-70. This road passes northwest-southeast across the middle of the quadrangle; several poorly maintained roads extend northeast and southwest from this principal roadway.

The quadrangle was first mapped geologically by C.T. Lupton (1916) at a scale of 1:62,500 as part of the U.S. Geological Survey coal-mapping program. Thereafter, Orkild (1956) produced a photogeologic map of the quadrangle (Emery 1NE). With some modification, the Orkild (1956) map was used in the first geologic map of Utah, which was printed at a scale of 1:250,000 (Hintze and Stokes, 1963). It was also included in a geologic map of the Salina quadrangle (1:250,000) by Williams and Hackman (1971). Doelling (1972) mapped part of the quadrangle at 1:33,500 as part of a study of the Emery coal field, and Doelling (2004) remapped the quadrangle as part of a 1:100,000-scale mapping project. The present project provides greater geologic detail at a larger scale.

STRATIGRAPHY

Sedimentary strata exposed in the Short Canyon quadrangle range in age from Middle Jurassic to Late Cretaceous, and have a total thickness of 3700 feet (1200 m). Several Quaternary units have been differentiated, including alluvial, eolian, mass movement, and mixed-environment deposits.

Subsurface Rock Units

Nearby drill holes have penetrated a normal stratigraphic sequence of formations below the oldest exposed units of the quadrangle. The Utah Plateau #1-X Federal well, SW1/4SW1/4 section 11, T. 22 S., R. 8 E., was spudded in the Entrada Sandstone about one mile (1.6 km) east of the quadrangle's east boundary. Reported thicknesses are:

Carmel Formation, 615 feet (187 m); Navajo Sandstone, 565 feet (172 m); Kayenta Formation, 250 feet (76 m); Wingate Sandstone, 374 feet (114 m); and Chinle Formation, 271 feet (83 m) (Utah Division of Oil, Gas and Mining, 2008).

The Amerada #1 Government Colman well, NW1/4SW1/4 section 17, T. 23 S., R. 9 E., is three to four miles (5–6 km) southeast of the southeast corner of the Short Canyon quadrangle. Reported thicknesses are: Chinle Formation, 264 feet (80 m); Moenkopi Formation, 816 feet (249 m); Kaibab Limestone, 23 feet (7 m); and the Cedar Mesa Sandstone, 900 feet (274 m) thick (Utah Division of Oil, Gas and Mining, 2008).

Jurassic Rocks

Carmel Formation, Winsor Member

The Carmel Formation is the oldest bedrock formation exposed in the Short Canyon quadrangle. Only the upper 50 feet (15 m) of the Winsor Member is exposed, but the total thickness is about 400 feet (130 m) (Doelling, 2004). The exposures are limited to the southeast corner of the quadrangle, all in sections 22 and 27, T. 22 S., R. 8 E. The outcrops form steep earthy slopes and consist of alternating green-gray and red-brown gypsiferous siltstone and calcisiltite, and thin alabaster gypsum beds. The Winsor Member of the Carmel is Middle Jurassic, Bathonian to Callovian in age (Douglas Sprinkel, Utah Geological Survey, written communication, 2009).

Entrada Sandstone

The Entrada Sandstone overlies the Carmel Formation in the southeast corner of the Short Canyon quadrangle. We measured 705 feet (215 m) of Entrada along the Red Ledges in sections 20, 21, and 22 in T. 22 S., R. 8 E. Wright and Dickey (1958), in an isopach map based on numerous surface sections they measured in this area, showed that the formation thickens westward, and is probably 600 to 800 feet (180–245 m) thick on the west flank of the San Rafael Swell near the Short Canyon quadrangle. Others (Morris and others, 2000; Hintze and Kowallis, 2009) indicated the Entrada is 400 to 900 feet (120–275 m) thick between Price and Cathedral Valley. The differences in thickness may be explained by the presence of the J-3 unconformity at the top, and the amount of erosion that took place prior to deposition of the overlying Curtis Formation.

The Entrada Sandstone is mostly fine-grained sandstone with a few medium- to coarse-grained lenses and subordinate siltstone beds and partings. It is mainly light brown to orange brown. Siltstone partings are generally darker brown. At irregular intervals, light-gray sandstone ledges divide units in the Entrada. The sand is cemented with calcium carbonate; toward the base of the exposed section secondary gypsum veinlets are locally present. It is generally exposed as cliffs, but also forms ridges, steep slopes, and benches along the Red Ledges and to the southwest.

We divide the Entrada into three informal members; lower (Jel), middle (Jem), and upper (Jeu). The lower member (Jel) is 295 feet (90 m) thick and forms smooth steep slopes. The outcrops weather earthy and, where exposed, are indistinctly bedded. The unit is criss-crossed with thin satin-spar gypsum veinlets that decrease upwards. The lower 50 to 55 feet (15–17 m) is bright red-brown and contains several thin gypsum beds, and the remainder is light brown and subtly banded.

The middle member (Jem) is about 255 feet (80 m) thick and forms cliffs and ledges divided by earthy weathering slopes. The cliffs are mostly thin to thick bedded and locally massive, and the ledges are commonly rippled. The lower part contains paper-thin gypsum veinlets and blebs of widely scattered pink chert nodules.

The upper member (Jeu) is 155 feet (45 m) thick. At its base, a gray-white sandstone ledge, 1 to 3 feet (0.3–1 m) thick, is medium to coarse grained, is moderately sorted, is cross-bedded, and has sucrosic weathering. Above this is a red-brown, massive, smooth-weathering sandstone unit. The lower half of this unit commonly weathers into knobs; the upper half forms a smooth bare-rock bench. The uppermost unit is red-brown sandstone that is thin to thick bedded and forms a vertical cliff; the upper 5 feet (2 m) forms thin ribs.

The Entrada Sandstone is considered Middle Jurassic (Callovian) in age (Anderson and Lucas, 1994). No fossils or other age indicators were found in the Entrada in the Short Canyon quadrangle, but it is between the underlying Carmel Formation that contains palynomorphs of Callovian age near the top, and the overlying Curtis Formation, which has yielded a few marine early Late Jurassic invertebrate fossils in the San Rafael Swell (Anderson and Lucas, 1994). A regional unconformity (J-3 unconformity) separates the Entrada from the overlying Curtis Formation. Pipiringos and O'Sullivan (1978) estimated the elapsed time between uplift and erosion of the Entrada and the onset of burial beneath the Curtis sediments to be less than 1 million years. The Entrada Sandstone correlates with the Preuss Sandstone in the central Wasatch Range and part of the Twist Gulch Formation in central Utah (Sprinkel, 1994).

Although the Entrada Sandstone clearly contains eolian-deposited sandstone in eastern and parts of southern Utah, the formation on the west flank of the San Rafael Swell (including the Short Canyon quadrangle) is different and undoubtedly water-laid. Morris and others (2000) in-

dicated the unit is the product of tidal flat deposition. Discussing its deposition in the area of Capitol Reef National Park (where outcrops are similar to those in Short Canyon quadrangle), Smith and others (1963) judged that the Entrada Sandstone was deposited in quiet water, and cited Baker and others (1936) and Craig and others (1955), who considered the deposition to have been largely subaqueous.

Curtis Formation

The Curtis Formation overlies the Entrada Sandstone in the southeastern and eastern parts of the quadrangle. We measured the Curtis in section 19, T. 22 S., R. 8 E., where the formation is 214 feet (65 m) thick, and in sections 27 and 34, T. 21 S., R. 8 E., where the formation is 202 feet (62 m) thick. Craig and Dickey (1956) reported that the Curtis is 250 feet (76 m) thick in the northern part of the San Rafael Swell, but that it thins to the south and east. In the Capitol Reef area to the south, the Curtis thins (Doelling and Kuehne, 2007), and pinches out a few miles south of the Wayne-Garfield county line.

In the Short Canyon quadrangle, the Curtis is mostly silty sandstone with minor siltstone and mudstone (sandy). At the base, it has a poorly sorted pebble conglomerate as much as 0.5 foot (0.2 m) thick, with gray pebbles ranging from coarse grit to 4 inches (10 cm) across, that are contained in a matrix of fine- to coarse-grained sandstone. The sandstone above is light gray, light green-gray, or light tan-gray, moderately to poorly sorted, muddy, and mostly calcareous. Most units are planar bedded; a few exhibit faint cross-stratification. Siltstone, wherever present, is medium gray in color. A few units, especially near the bottom contain scattered pebbles.

The Curtis Formation consists of two informal units: a lower mostly cliffy unit 95 to 105 feet (29–32 m) thick, and an upper slope former about 85 to 100 feet (26–30 m) thick. The lower member (Jcl) forms a cliff with the upper Entrada member (Jeu) and has a broad bench, partially covered with mixed eolian and alluvial sand (Qea), at its top (South Sand Bench). The lower 25 feet (8 m) of the lower member is a green-gray calcareous siltstone and sandy shale. It forms a slightly recessed vertical cliff and locally a steep slope between the uppermost Entrada and the cliffy sandstone. The cliffy part of the lower member is mostly light-gray, fine- to medium-grained, calcareous sandstone that is largely thin to medium bedded, but locally thick to very thick bedded. The beds weather into nearly structureless slabby planar blocks. The thicker beds locally exhibit some eolian cross-bedding, knobby weathering, and large tafoni ("stonepecker" holes).

The upper member (Jcu) exhibits a deeper green-gray, light-brown, and light-purplish coloration. It displays a series of low slopes capped by thin ledges. Although fine-grained sandstone remains the dominant lithology, siltstone and mudstone are more abundant than in the lower member. The slopes are earthy or exhibit the thin-bedded to shaly nature of the rock. The thin ledges weather into thin platy material, pancake-shaped plates, or chips. The Curtis is one of the easiest formations to identify in the quadrangle, forming a light band between the brownish Entrada below and the brownish Summerville Formation above.

The age of the Curtis Formation is early Late Jurassic. The Curtis had been considered Callovian in age (see Hintze, 1988, p. 47), but recent palynological work by Wilcox and Currie (2006) showed that it is early Oxfordian (earliest Late Jurassic ~161 to 156 Ma). The Curtis Formation and its correlatives were probably deposited in a single transgressive-regressive sequence recording the final pulse of the Jurassic interior seaway. The Curtis Formation correlates with the Stump Sandstone of northern Utah. The Curtis in the Short Canyon quadrangle is conformably overlain by the Summerville Formation.

The Curtis sediments were deposited in a shallow-water marine environment (Craig and Dickey, 1956), and some of the sandstone is glauconitic. Glauconite is a cementing mineral that forms only in marine environments where sedimentation rates are relatively low. However, the moderate to poor sorting in the lower part of the Curtis Formation of the Short Canyon quadrangle might indicate some wave action.

Summerville Formation

The Summerville Formation overlies the Curtis Formation with a conformable, gradational contact in the Short Canyon quadrangle. We measured it in section 19, T. 22 S., R. 8 E., northwest of the Canyon Pond where it is about 295 feet (90 m) thick. We also measured it north of Dry Wash where it is 255 feet (80 m) thick. The Summerville Formation was defined by Gilluly and Reeside (1928) at Summerville Point in the northern San Rafael Swell where it has a thickness of about 165 feet (50 m). In the San Rafael Swell, the upper boundary with the Morrison Formation is the J-5 unconformity, and the Summerville Formation varies considerably in thickness due to gentle folding and erosion prior to deposition of the Morrison. Although such synclines and anticlines are not persistent throughout the San Rafael Swell area, beveling of the formation beneath the unconformity probably accounts for differences in thickness of the Summerville. Trimble and Doelling (1978) reported that the Summerville thickness in the San Rafael River mining area, on the east side of the San Rafael Swell, varies from 105 to 400 feet (32–122 m) because of small-amplitude folds in the unit.

The Summerville Formation ordinarily forms a steep, con-

vex slope punctuated by a few ledges. In the Short Canyon quadrangle, it consists of very fine grained silty sandstone interbedded with thin siltstone beds. It is generally evenly bedded, but not as evenly bedded as in the eastern part of the San Rafael Swell (Doelling, 2004). The bedding ranges from laminar (a few millimeters) to medium (as much as 2 feet [0.6 m]). The thickest beds generally form ledges. Light- to medium-brown beds dominate (80%), although the thinnest and thickest beds are very light gray (20%). A few thin beds of gray limestone are also present, and the Summerville is generally calcareous.

The age of the Summerville Formation, like the Curtis Formation, is early Late Jurassic. The Summerville Formation had been considered to be Callovian in age (Hintze, 1988, p. 47), but recent palynological work by Wilcox and Currie (2006) show that the unit is early Oxfordian in age (earliest Late Jurassic; ~161 to 156 Ma). The Summerville was probably deposited in shallow quiet waters as might occur under tidal-flat conditions (Craig and Dickey, 1956). Common features associated with the Summerville beds are mud cracks and ripple marks.

The Summerville Formation in the Short Canyon quadrangle is overlain by the Tidwell Member of the Morrison Formation. Pipiringos and O'Sullivan (1978) indicated that the contact is a regional unconformity (J-5 unconformity) with a hiatus of about 2 million years; however, in this area the unconformity is not obviously displayed and appears gradational. However, a subtle bench or a reduction in the overall slope angle is present at the contact. The contact is placed where the light- to medium-brown overall color of the Summerville changes to the conspicuously red-brown coloration of the Tidwell Member.

Morrison Formation

The Morrison Formation is generally divisible into three members in the San Rafael Swell and Castle Valley areas: in ascending order, the Tidwell, Salt Wash, and Brushy Basin Members. The Morrison is about 570 to 580 feet (174–177 m) thick in the Short Canyon quadrangle. In the quadrangle, the Tidwell and Brushy Basin Members thicken southward, whereas the Salt Wash Member is thickest in the north.

Tidwell Member: The Tidwell Member of the Morrison Formation overlies the Summerville Formation in the quadrangle. In the southern part of the quadrangle (NW ¼ sec. 19, T. 22 S., R. 8 E.) the Tidwell is 90 feet (25 m) thick. In the northern part of the quadrangle (sec. 33, T. 21 S., R. 8 E.) the member is about 70 feet (20 m) thick.

The Tidwell Member is slope forming, bright red-brown, locally mottled siltstone and subordinate, very fine grained, platy-weathering sandstone. Scattered throughout are thin gypsum beds that become more numerous and thicker toward the top. The thickest gypsum bed near the top is as much as 14 feet (4 m) thick. The gypsum beds are silty, weather frothy or hackly, and are impure alabaster. Many of the siltstone beds contain flattened blebs and lozenges of pink gypsum. Locally, light-gray, gritty, medium- to coarse-grained sandstone beds are present near the base or middle of the member.

The Tidwell is Late Jurassic in age (Kimmeridgian) (Demko and others, 2004; Hintze and Kowallis, 2009), and the upper contact is placed above bright red-brown siltstones of the Tidwell and below either a smooth, slope-forming, medium-gray, silty sandstone or gray hard conglomerate of the Salt Wash Member.

Salt Wash Member: The Salt Wash Member of the Morrison Formation overlies the Tidwell Member in the quadrangle. We measured about 95 feet (29 m) of Salt Wash Member in the southern part (section 13, T. 22 S., R. 7 E.), and 225 feet (69 m) in the northern part (sections 28 and 29, T. 21 S., R. 8 E.) of the Short Canyon quadrangle. The contact between the Salt Wash and Brushy Basin Members is difficult to place, and is mostly marked with a dashed line on the geologic map (plate 1). Regionally, the Salt Wash Member contains sandstone, conglomeratic sandstone, and conglomeratic units, but in the Short Canyon quadrangle it has more shaly units. We mapped the contact just below a brightly banded unit of the Brushy Basin Shale Member, which continues persistently across the quadrangle.

The Salt Wash Sandstone Member consists of lenticular and discontinuous, mostly gray conglomerate, conglomeratic sandstone, and sandstone ledges interbedded with light-gray, green-gray, lavender, purple, and red silty and sandy mudstones. The mudstones dominate (70 percent) over the ledge-formers (30 percent) in the northern part, and are more equally distributed in the southern part of the quadrangle. The ledges typically increase near the base and top of the Salt Wash Member.

The ledges contain poorly sorted, subangular grains to cobbles, are mostly medium to thick bedded and trough cross-stratified, contain partings of variously colored siltstone mudstones, and are generally calcareous. Some conglomerates are hard and well indurated, while others are loosely cemented. A few beds contain imprints of logs and branches.

The mudstones commonly contain carbonized plant debris, and are color banded, calcareous, and indistinctly bedded. Sandy mudstones may grade laterally into ledge-formers. The mudstones form undulating to steep slopes.

These beds are normally assigned a Late Jurassic age (Kimmeridgian) (Hintze and Kowallis, 2009; Demko and others, 2004). The upper contact is placed above the up-

permost ledges of gray conglomerate, conglomeratic sandstone, or coarse sandstone or gray, green gray, lavender, or purple mudstones, and below the brightly banded outcrop of the Brushy Basin Member.

Brushy Basin Member: The Brushy Basin Member overlies the Salt Wash Member everywhere on the Short Canyon quadrangle. We divided the member into two informal units on the geologic map (plate 1). The lower and thickest part is a brightly banded unit (Jmbb) that is overlain by a purple unit of shale or mudstone (Jmbp). The entire Brushy Basin is 285 to 385 feet (87–117 m) thick, and is thickest in the southern part of the quadrangle. The lower banded unit is 205 to 265 feet (60–80 m) thick and the purple unit is 80 to 120 feet (25–35 m) thick. The age of the Brushy Basin Member is Late Jurassic (Tithonian) (Demko and others, 2004; Gradstein and Ogg, 2009; Hintze and Kowallis, 2009).

The brightly banded unit of the Brushy Basin Member forms a steep smooth slope, which is thin to thickly banded in shades of light-gray, light-brown, or light-purple. It is mostly mudstone made up of clay, silt, fine-grained sandstone, and is commonly bentonitic. The unit also contains scattered horizons of brown limestone nodules, thin white sandstone, and lenticular conglomeratic beds.

The purplish silty mudstone unit forms a steep slope that is commonly divided in two by a persistent ledge of sandstone and conglomerate. It also contains many horizons of brown limestone nodules that break up and litter the slope surfaces. Where the Buckhorn Conglomerate Member of the Cedar Mountain Formation has been channeled into the purple unit, the upper contact is easily discernible; however, where mudstones of the Cedar Mountain Formation are found above it, we placed the contact where the purple is replaced by green-gray mudstone.

Cretaceous Rocks

Cedar Mountain Formation

The Cedar Mountain Formation forms mostly light-gray or light-greenish-gray, smooth, rounded slopes beneath the yellow-gray sandstone of the Dakota Formation. We recognize four members in the Short Canyon quadrangle (in ascending order): the Buckhorn Conglomerate, Ruby Ranch Member, Short Canyon member (new informal name), and Mussentuchit Member.

Buckhorn Conglomerate Member: The Buckhorn Conglomerate Member is locally present at the base of the Cedar Mountain Formation. This lower member is lenticular in the Short Canyon quadrangle, and is included with the Ruby Ranch Member where the Buckhorn is very thin on the map. The Buckhorn is generally 0 to 40 feet (0–12 m) thick.

The Buckhorn Conglomerate Member is composed of sandstone, conglomeratic sandstone, conglomerate, and mudstone with an overall gray-brown color, and generally forms rubbly, cliffy ledges and benches. These beds are lenticular, poorly to moderately sorted, and trough cross-stratified. Generally, the pebble and cobble clasts are subangular to subrounded chert. Some beds are clast supported while others are matrix supported. The matrix is mostly medium- to coarse-grained sandstone. The subordinate mudstone units are present as partings and beds between the coarser-grained units. The mudstone is light- to dark-gray, argillaceous, locally carbonaceous and sandy, and indistinctly bedded, and forms recesses and slopes between ledges. The Buckhorn Conglomerate Member appears conformable with the overlying Ruby Ranch member. Lenticular sandstone beds are generally present in the Ruby Ranch Member directly over the Buckhorn channels.

Greenhalgh and Britt (2007) considered the Buckhorn to be Barremian-Aptian (late Early Cretaceous) in age, but noted that no diagnostic fossils have been found within it. Some workers used a regional calcrete bed that is near the base of the Cretaceous, but locally above the Buckhorn, to place the Buckhorn in the Jurassic (Aubrey 1996, 1998; Currie, 1997). However, Kirkland and Madsen (2007) showed that there are several unrelated calcrete beds and that they are post-depositional and cut across bedding. We follow Greenhalgh and Britt (2007) and Kirkland and Madsen (2007) and consider the Buckhorn late Early Cretaceous in age and as the basal unit of the Cedar Mountain Formation. The Buckhorn is discontinuous throughout the Colorado Plateau region beneath the other members of the Cedar Mountain Formation. It may laterally interfinger with the Yellowcat Member (not present in this quadrangle) (Greenhalgh and Britt, 2007), and is overlain sequentially by the Poison Strip (also absent in this quadrangle), Ruby Ranch, and Mussentuchit Members (Kirkland and others, 1997).

Ruby Ranch Member: The Ruby Ranch Member, which forms a continuous outcrop belt in the quadrangle, varies from 76 to 131 feet (23–40 m) in thickness. Kirkland and others (1999) indicated it is separated from the overlying Mussentuchit Member by an unconformity, which may explain the variation.

The Ruby Ranch Member is mainly clayey and silty mudstone, but locally has accumulations of lenticular sandy mudstone and ledgy sandstone that are more common above the Buckhorn Conglomerate channels. The fresh unweathered mudstone is generally dark gray to dark purple gray and is darker in color than on the weathered slopes. Commonly, the mudstone contains layers of medium-brown or medium-brown-gray limestone nodules. These nodular layers break up on weathering, and where abundant, nodules cover much of the slope surface. The sandstone, where present, is mostly poorly sorted and ranges

from fine grained to pebbly. Where fresh, the mudstone breaks conchoidally into small to large, angular, equidimensional fragments.

The Ruby Ranch Member generally forms "bumpy" to smooth-weathering, light-gray to light-greenish-gray slopes with abundant carbonate nodules littering the slopes. Where the Buckhorn Conglomerate Member is not present, light-hued, medium to thick mudstone beds that vary in resistance and steepness form a continuous slope from the top of the Salt Wash Member to the base of the Mussentuchit Member. The Brushy Basin Member slopes are generally smoother than the Ruby Ranch Member mudstones. Subtle, slightly less variegated, and duller overall color banding, indicative of variations in the mudstone bedding, is more common in the Ruby Ranch Member.

The age of the Ruby Ranch Member is Early Cretaceous (Aptian-Albian) according to fossil evidence and radiometric and stratigraphic relations (Kirkland and others, 1999; Kirkland and Madsen, 2007). The Ruby Ranch Member is generally present everywhere the Cedar Mountain Formation is exposed throughout the Colorado Plateau region, but is missing in southwestern Utah (Kirkland and others, 1999; Jim Kirkland, Utah Geological Survey, verbal communication, 2008).

Short Canyon member: We introduce a new informal member of the Cedar Mountain Formation with a type section located on the north side of Short Canyon in section 20, T. 21 S., R. 8 W. The member is discontinuous and most prominent in the north half of the quadrangle. It represents a channel deposit that preceded and was partly contemporaneous with the deposition of the Mussentuchit Member and is much like the Buckhorn Member at the base of the Ruby Ranch Member. In the north half of the Short Canyon quadrangle it resembles the Dakota Formation as well.

The Short Canyon member consists of one to three resistant ledges of conglomerate, conglomeratic sandstone, and sandstone, that are separated by slope-forming sandstone, local gray to black carbonaceous (and possibly coaly) shale, and rare, thin gypsiferous sandstone lenses. The ledges and cliffs are various shades of gray, gray brown, and brown, and are cross-stratified and commonly trough cross-bedded. The conglomerate contains poorly sorted, subrounded to subangular grit to cobbles as much as 4 inches (10 cm) across. The clasts consist of quartzite, siliceous limestone, and sandstone and are poorly to well cemented with calcite or silica. The abundance of quartzite clasts distinguishes the Short Canyon member from the Buckhorn Conglomerate (Gary Hunt, Utah Geological Survey, verbal communication, 2009). The sandstone in the ledges is also poorly sorted, and some beds are very fine to medium grained but others are fine to coarse grained. The cementation varies in degree, and is calcareous or siliceous, but the rock is mostly firm. The ledges probably represent channel deposits of an ancient river system. Carbonaceous shale and coaly shale as much as 2 feet (0.6 m) thick and rare gypsiferous sandstone lenses are present in the highest parts of the principal ledges.

Slope-forming, muddy sandstone separates the ledge-forming rock. Beds are fine to medium grained; light gray, green gray, orange, and light brown; poorly cemented; and friable. Cementation is principally calcareous. Locally present in the earthy-weathering slopes are very small rip-up clasts of nearly white mudstone, and well-indurated sandstone forms a slight ledge in the slope. The slope-forming, muddy sandstone is generally lighter and less structured than mudstone in the Mussentuchit Member.

As ascertained by Kirkland and others (1999), the Ruby Ranch and Mussentuchit Members contact is an unconformity. The Short Canyon member is a channel-form deposit laid down above the plane of unconformity. Such channels are not present in the southern part of the quadrangle, but subparallel the Cedar Mountain Formation outcrop belt in the north. The Short Canyon member continues in outcrop into the Molen quadrangle to the north. A channel or set of channels is thickly developed where the Cedar Mountain Formation outcrop belt crosses Short Canyon. There are at least three channel ledges: the lowest cuts deeply into the Ruby Ranch Member, and the highest rises into the Mussentuchit Member above. Although we could not actually pinpoint a place, the Dakota Formation may locally rest directly on the Short Canyon member. However, at one location we measured 104 feet (32 m) of the Short Canyon member and only 38 feet (12 m) of the Mussentuchit Member. The lowest ledge is widest and the highest is the narrowest. The lower contact with the Ruby Ranch Member is wavy and irregular. The upper contact with the Mussentuchit Member is relatively abrupt and discordant to regional bedding and probably represents the boundary between the sides of channels and overbank or lacustrine deposits.

Mussentuchit Member: The Mussentuchit Member unconformably overlies the Ruby Ranch Member wherever they are in contact. Where it overlies the Short Canyon member, the contact is conformable. The Mussentuchit Member is continuous across the quadrangle ranging from 38 to 110 feet (12–33 m) thick, and generally thins northward. It differs from the Ruby Ranch by the lack of nodular limestone horizons and by an increase of volcanic ash material in the mudstone. The type section of this member was designated by Kirkland and others (1997) at a location on the south side of Mussentuchit Wash in the Willow Springs quadrangle, about 12 miles (19 km) to the south. The upper contact with the Dakota Formation is an unconformity.

The mudstone of the Mussentuchit Member weathers into light-gray, white, and light-green-gray colors. The mudstone is smectitic, sandy, or silty. Ledges locally include

some medium green-gray, fine- to medium-grained sandstone. Like the Ruby Ranch, differences in resistance afford variable slopes with changes in slope angle. Locally, some dark lignitic horizons are present, especially near the top of the unit.

The radiometric age of the Mussentuchit Member has been established as 98.39 Ma obtained by Cifelli and others (1997), and Garrison and others (2007). Thus, this member is considered Cenomanian in age based on Gradstein and Ogg (2009). The Mussentuchit Member has also yielded a rich dinosaur fauna. The member crops out mostly along the west flank of the San Rafael Swell and extends into southwest Utah (Biek and others, 2003; Biek and others, 2007). It correlates to the Mowry Shale in northern Utah (Sprinkel, 2007) but is not present in many parts of the Colorado Plateau region.

Dakota Formation

The Dakota Formation is also locally known as the Dakota Sandstone. Inasmuch as the Dakota is mostly shale in the Short Canyon quadrangle, we use the term "formation." In its full development in the quadrangle, it consists of a lower slope, a lower sandstone ledge or cliff, a middle slope, an upper sandstone ledge or cliff, and a thin, pebbly upper slope containing *Pycnodonte newberryi* (oyster shell fossils). The five divisions are not developed everywhere in the quadrangle; in many areas the upper sandstone ledge is thin or missing, and in other areas the lower sandstone ledge is thin or missing. The lower boundary is an unconformity. The upper boundary is mapped where overlying deeper marine (Mancos Shale) deposits first occur. In some areas of the San Rafael Swell, a local unconformity has been identified near the base of the upper slope that contains pebbles and *Pycnodonte newberryi* fossils (Eaton and others, 1990; Jim Kirkland, Utah Geological Survey, verbal communication, 2008). However, for mapping purposes we have included the thin slope interval in the Dakota Formation following Lawyer (1972) and Peterson and others (1980). The Dakota is 50 to 100 feet (15–30 m) thick. The thickness varies, but is generally thickest in northern exposures.

The Dakota Formation consists of interbedded sandstone, shale, carbonaceous shale, coal, conglomeratic sandstone, and conglomerate. The sandstone ledges or cliffs consist of thin to thick lenses of sandstone and conglomerate. The sandstone beds are generally light hued, including yellow, orange gray, light tan gray, or very light brown. They are commonly fine to medium grained, but locally they contain rounded or subrounded pebbles and cobbles that grade into gray conglomerate; most are well to moderately sorted. Partings in the ledges and cliffs consist of carbonaceous shale or gray shale. The conglomerate and sandstone commonly exhibit trough cross-beds. Burrows and plant imprints are locally common. The carbonaceous shale partings commonly contain plant debris. The rock is moderately cemented with calcite. Locally, the sandstone contains pyrite nodules, but most have altered to brown limonite.

The slopes contain irregularly bedded mudstone, siltstone, sandy shale, gray shale, carbonaceous shale, coal, muddy sandstone, and brown sandstone. Except for the brown sandstone, the strata weather into slopes and recesses. The most common colors are shades of gray or gray brown. Coal beds, where present, are very thin and lenticular, rarely exceeding 6 inches (15 cm) in thickness, although one may be up to 1.5 feet (0.5 m) thick. Except for the brown variety, most sandstone beds are friable and fine grained. The brown variety of sandstone is typically thin-bedded and cemented with calcite. The Dakota Formation is Late Cretaceous (Cenomanian) in the Short Canyon quadrangle (Eaton and others, 1990; Molenaar and Cobban, 1991).

Mancos Shale

The Mancos Shale is represented by three members on the west side of the Short Canyon quadrangle. These are (ascending order) the Tununk Member, Ferron Sandstone Member, and Blue Gate Member. The Mancos Shale was deposited during the time of the Cretaceous Western Interior Seaway.

Tununk Member: The Tununk is the oldest of the Mancos Shale members and represents the westernmost incursion of the Western Interior Seaway. In the quadrangle, it is present beneath the Molen Reef in a southwest-to-northeast band as a steep concave slope; locally as a vertical cliff. We measured the Tununk Member in the NW 1/4 section 14, T. 22 S., R. 7 E., where it was about 675 feet (205 m) thick.

The Tununk Member is composed of marine mudstone and shale that is medium to dark brown or gray and locally black, and that breaks into equidimensional fragments when excavated. The unit is soft, silty, and sandy (fine grained) near the bottom and top. Bedding is mostly indistinct to thin and laminated. The Tununk contains secondary gypsum veinlets and is mostly calcareous. In the upper 50 feet (15 m), the shale is interbedded with thin, brown to gray, very fine grained sandstone beds that are about 1 foot (0.3 m) apart. The upper contact is mapped at the base of the first medium or thick sandstone bed of the overlying Ferron Sandstone Member.

About 100 feet (30 m) below the top of the member is a conspicuous ledge of sandstone, about 25 feet (8 m) thick, which we informally call the Moore sandstone bed (not mapped). The sandstone is light-gray, fine grained, blocky, and massive.

The Tununk Member overlies the Dakota Sandstone at most locations in the Colorado Plateau region. It correlates with the Tropic Shale in southwestern Utah (Hintze and Kowallis, 2009). Fossils indicate it is Late Cretaceous (Cenomanian) in age (Molenaar and Cobban, 1991).

Ferron Sandstone Member: The Ferron Sandstone Member of the Mancos Shale generally forms a series of sandstone cliffs above the steep slope of the Tununk Shale Member and is 325 feet (100 m) thick in the quadrangle, thinning to the northeast. It consists of interbedded yellow-gray, light-brown, and white sandstone, gray sandy shale, dark-gray carbonaceous shale, and dark gray to black coal. The sandstone is mostly fine to medium grained, mostly calcareous, thin to massive lenticularly bedded, cross-stratified, rippled, bioturbated, and contorted. The member contains limonitic nodules (some still have pyrite cores) and thin lenticular coal beds up to 2.3 feet (0.7 m) thick.

The Ferron Sandstone overlies the Tununk Member conformably. It was deposited in fluvial, deltaic, and lagoonal environments. It correlates with the Tibbett Canyon and Smoky Hollow Members of the Straight Cliffs Formation in the Kaiparowits Plateau. It is exposed near the Henry Mountains to the southeast, where it is thinner. It surrounds the northern half of the San Rafael Swell, but thins northeastward from Short Canyon, eventually losing its cliff-forming character. Fossils indicate it is Late Cretaceous (Turonian) in age (Molenaar and Cobban, 1991). The lower part is middle Turonian, and the upper feldspathic part is upper Turonian (Gardner, 1995; Ryer and Anderson, 2004).

Blue Gate Member: Like the Tununk Member, the Blue Gate Member of the Mancos Shale forms steep earthy slopes. It forms most of the surface of Castle Valley, west of the Short Canyon quadrangle. It differs from the Tununk Member in being a lighter shade of gray and exhibiting more laminated and thin beds. It is the youngest sedimentary bedrock unit with approximately 300 feet (100 m) exposed in the quadrangle. The entire lower part of the Blue Gate Member is about 1600 feet (490 m) thick in this part of Castle Valley.

The lower Blue Gate Member is mostly evenly bedded, pale blue-gray, marine shale, which is irregularly interbedded with siltstone and several yellow-gray sandstone beds that are slightly more resistant. The member forms a broad badlands slope with thin ledges. The Blue Gate Member is present below the Book Cliffs in the Colorado Plateau region and in the Henry Mountains basin. It correlates with the John Henry Member of the Straight Cliffs Formation in the Kaiparowits Plateau area (Peterson, 1969). Santonian-age (Late Cretaceous) fossils are present in the lower Blue Gate Member and overlying Emery Sandstone (Peterson and others, 1980).

Quaternary Deposits

Alluvial Deposits

Stream alluvium: Clay- to boulder-size clasts are common along courses of modern washes and stream channels, including Short Canyon and Dry Wash. They are unconsolidated and poorly to moderately sorted, and consist of interlayered coarse and fine lenses. The coarsest materials are commonly in the wash channel. Generally two other levels of alluvium (terraces?) are discernible (not mapped), one about 5 feet (2m) above the wash channel, the next about 25 feet (8 m) above the first level. Higher levels were not observed in this quadrangle. Sources are varied, but the alluvium of the major drainages consists dominantly of Mancos Shale mud and very fine-grained sand. Dry Wash, for example, is dominated by gray, finely laminated Mancos mud (clay, silt, and very fine-grained sand), with very thin streaks of fine-grained sandstone derived from the Summerville Formation. The walls of the highest level commonly stand vertical. The upper surfaces of the levels are coarsely fluted in the direction of flow. The base of the wash channel and that of the 5-foot (2 m) level generally contain some gravel from the Morrison and Cedar Mountain Formations where the alluvium is below these outcrops; a small percentage from the Ferron Sandstone, Dakota, and Summerville Formations may also be present.

The alluvium of the major channels is probably no thicker than 30 feet (9 m) and its presence suggests a period of canyon or valley filling. Currently, the highest levels of the alluvial deposits are being eroded by the washes (downcutting mode) and suggest that at one time they were laid down on top of previously eroded bedrock surfaces. The alluvium deposits are Holocene to late Pleistocene.

Alluvial mud: Light gray mud, mostly derived from Mancos Shale Members, has been deposited as valley fill, slope wash, and fans in the northwest part of the quadrangle. It consists dominantly of unconsolidated clay, silt, and sand particles in deposits that are mostly structureless, laminated, or crudely stratified. Alluvial mud deposits are probably not more than 15 feet (5 m) thick in this quadrangle and are probably Holocene to late Pleistocene.

Alluvial-fan deposits: Alluival-fan deposits generally consist of unconsolidated silt to cobble-size particles that are carried from surrounding bedrock outcrops by torrential rainfall and are deposited where washes experience a reduction in gradient, forming fan-shaped deposits. Alluvial-fan deposits are much like the alluvial mud deposits in that they are derived from local sources; however, they contain less mud. They commonly interfinger with the alluvium of prominent drainages at their lower ends and are currently being gullied headward by the tributaries of these prominent drainages. As mapped, they commonly contain minor

quantities of alluvium and eolian deposits. These fan deposits are less than 15 feet (5 m) thick, generally cover bedrock, and are Holocene to late Pleistocene.

Pediment-mantle deposits: These deposits consist of unconsolidated silt to gravel-size material with local accumulations of sandstone boulders that are generally derived from nearby bedrock. Pediment deposits in the southeast corner of the quadrangle represent an old alluvial surface that developed on the lower Entrada Sandstone and the Winsor Member of the Carmel Formation, and has subsequently been dissected. The deposits slope northwestward, indicating that the source was toward the San Rafael Swell. They do not vary much in thickness and consist of chippy and platy limestone gravel mixed with light-brown, very fine-grained sand that is about 4 feet (1.3 m) thick. In many places southeast of South Salt Wash this gravel is overlain by 2 to 3 feet (0.7–1 m) of gypsite, impure gypsum mixed with silt and very fine grained sand.

A few pediment deposits are found on the Summerville and Curtis Formations (mostly on the Curtis) on the west side of North Salt Wash between the Moore Road and Dry Wash. They may represent the deposits of a paleo-North Salt Wash but are now aligned along a ridge west of the wash. They are composed of quartzite gravel, chalcedony (chert), limestone, gritstone, and siltstone in poorly sorted fine to coarse sand. The gravel contains clasts to 5 inches (12 cm) across, but is dominated by 1/2-inch to 1-inch (1–2.5 cm) pieces, all poorly sorted. The clasts are mostly derived from the Cedar Mountain Formation and Morrison Formation, with a small component from the Summerville Formation. These deposits drape down toward the wash and may be partly colluvial, with maximum thickness probably not more than 15 feet (5 m) thick. Similar small Qap deposits are scattered along the Dry Wash drainage and in other areas of the quadrangle. Qap deposits are considered mostly Holocene to early Pleistocene.

Mass-Movement Deposits

Landslide deposits: Landslide deposits are not common in the Short Canyon quadrangle. However, a few have developed below cliff-forming units resting on shale. The smallest are grouped with the talus and rock-fall deposits (Qmtc); only larger deposits were mapped. The Coal Cliffs or Molen Reef consists of the Ferron Sandstone Member resting upon the steep slope of the Tununk Member of the Mancos Shale. In some places, the sandstone cliff has separated from the main mass of the lower part of the Ferron Sandstone Member and slipped on the Tununk Shale as rotational blocks. The rotational blocks are generally broken into many large pieces. In at least one place, the same has occurred with the Dakota Formation resting on the Mussentuchit Member of the Cedar Mountain Formation. Thicknesses vary and most deposits are Holocene to late Pleistocene.

Talus, colluvium, and rock-fall deposits: Deposits of accumulated rock debris occur on slopes below cliffs and ledges. Large blocks that have broken off and fallen from a ledge or cliff are ubiquitous in the quadrangle; only the larger deposits are mapped. They are especially prevalent below the Molen Reef on the steep slope of the Tununk Member of the Mancos Shale.

These deposits rarely exceed 5 feet (1.5 m) in thickness and consist of poorly sorted angular fragments. Rounded fragments in talus were probably rounded prior to having been incorporated in the parent formation. These deposits are considered Holocene to late Pleistocene.

Mixed-Environment Deposits

Mixed eolian and alluvial deposits: Most of these deposits rest upon the lower Curtis Formation (Jcl) and largely cover the slopes down dip from the ledge formed at the Curtis-Entrada contact. The sand is mostly fine to medium grained and is derived from the Curtis Formation, and thought to be the product of both sheet wash and eolian processes. Small amounts of fine to medium gravel are found in the deposits, and the amount of gravel increases to the northwest. They are Holocene to late Pleistocene in age.

STRUCTURAL GEOLOGY

Regional Structural Setting

The Short Canyon quadrangle is located on the gently dipping western flank of the San Rafael Swell. Structurally, the area is a basin, as reflected by regional strikes and dips of the strata. Structure contours show the strikes generally to be north-northeasterly ranging from N. 25° E. to N. 50° E. Along this trend, dips average between 2 and 7 degrees to the northwest into the basin. Locally in the northwest corner of the quadrangle, dips increase to as much as 10 degrees.

Folds and Faults

A pair of north-south trending fold axes in sections 26 and 27, T. 21 S., R. 7 E., can be traced for about 1.25 miles (2 km), and involve strata of the Ferron Sandstone Member of the Mancos Shale. Both the syncline (east) and anticline (west) plunge northward at about 2 degrees before dying out. Dips within the Molen Reef range from 5 to 7 degrees northwesterly, flatten out at the syncline, then dip 1 to 4 degrees easterly up to the anticline (about 0.6 mile [1 km]) before dipping northwesterly again toward Castle Valley.

Faults are rare in the Short Canyon quadrangle, and have only minor displacements. Only one small displacement

fault was mapped in the southwest corner of the map area. The structural setting surrounding the Short Canyon quadrangle is discussed in Neuhauser (1988) and Tripp (1989).

ECONOMIC GEOLOGY

Petroleum and Gas Possibilities

No wells have been drilled for petroleum or gas in this quadrangle. Wildcat wells were drilled to test the Sinbad Member of the Moenkopi Formation on the adjacent Sid and Charley quadrangle to the east, but proved dry (Utah Division of Oil, Gas and Mining, 2008). Several wells encountered gas along an anticline in the Ferron Sandstone Member of the Mancos Shale north of the quadrangle near the town of Ferron. However, the Ferron is eroded at the surface in the Short Canyon quadrangle, and the possibility for hydrocarbon discovery is deemed low. Several papers have been written on petroleum and gas potential including Tripp (1989), Gloyn and others (2003), and U.S. Geological Survey Uinta-Piceance Assessment Team (2003).

Coal

Coal is present in the Ferron Sandstone Member of the Mancos Shale and in the Dakota Formation. The area is a part of the Emery coalfield. The Ferron Sandstone coals were originally evaluated by Lupton (1916); additional work was added by Doelling (1972) and Quick and others (2004).

The Short Canyon quadrangle is located at the very north end of the coalfield and no economic deposits are known. Doelling (1972) and Quick and others (2004) reported that the thickest bed in the quadrangle is found in the southwest corner of section 35, T. 21 S., R. 7 E., where it is 1.9 to 2.3 feet (0.6–0.7 m) thick. The bed is lenticular and discontinuous, and over a short distance (100 feet [30 m]) dissipates into even thinner beds and bone coal.

Coal in the Dakota Formation is generally very thin and commonly missing, but at one location (NE ¼ sec. 22, T. 22 S., R. 7 E.) it is 1.5 feet (0.5 m) thick.

Gypsum

Gypsum beds are present in the Winsor Member of the Carmel Formation, in the lowermost member of the Entrada Sandstone, and in the Tidwell Member of the Morrison Formation. Exposures at the surface in the Carmel and Entrada are generally thin, rarely exceeding 2 feet (0.6 m) in thickness. The Tidwell generally contains several beds, but only the uppermost is thick; locally this bed is as much as 13 feet (4 m) thick, but contains siltstone partings, is impure, and weathers frothy and hackly.

Other Resources

Chalcedony is abundant locally in the Morrison and Cedar Mountain Formations. Red (jasper), yellow (citrine), and gray (flint) chalcedony could be worked into jewelry. Various types of nodules and other rock oddities are found at many quadrangle localities, which might interest “rock hounds.”

Water Resources

The Short Canyon quadrangle is located on the edge of a middle-latitude desert at the foot of the Wasatch Plateau. Annual precipitation ranges from 6 to 8 inches (15–20 cm), the higher amount falling in the higher elevations (Richardson and others, 1980). Elevations range from a low of about 5720 feet (1740 m) (where South Salt Wash exits the quadrangle in the southeast corner) to a high of about 6930 feet (2113 m) along the Molen Reef near the southwest margin of the quadrangle. All drainages are ephemeral, generally draining the area from west to east. However, after a series of wet years, Dry Wash and Short Canyon may have flowing water in their channels for short distances.

The Short Canyon quadrangle provides winter grazing for cattle, and water catchments have been constructed across the quadrangle. Most of these catchments collect flow in small washes, which channel water for a short time after a brief rainfall or snowfall. Every few years a torrential summer rainfall causes flash floods in many of the washes, destroying the catchment dams. These catchments are quickly repaired for the winter grazing season. Groundwater studies in the area include that by Lines and Morrissey (1981).

GEOLOGIC HAZARDS

Landslides and Rock Falls

Few landslides (Qms) were mapped in the Short Canyon quadrangle. Rock falls occur sporadically; they are most evident at the foot of the Molen Reef, but can occur from any cliff-forming unit. Large angular boulders in Qmtc deposits attest to previous rock-fall events.

Debris Flows and Flooding

Flooding-induced erosion and deposition are the most active and potentially damaging geologic hazards in the quadrangle, especially in areas of mapped young alluvial deposits. The sparsely vegetated slopes, benches, and deep, narrow washes are subject to rapid erosion from waters generated by cloudburst rainstorms. Debris flows and floods generally remain confined to stream channels

in high-relief areas, but may exit channels and deposit debris where slope gradients decrease or channels are shallow along their travel paths. Debris flows and stream floods regularly damage the few roads in the Short Canyon quadrangle. These hazards are directly related to torrential rainfall, which is more likely to occur in the late summer season, although long, steady rains and snowmelt in the spring can also cause damage. Because most roads are not surfaced or paved, those crossing the shale members of the Mancos can become so muddy that travel over them is extremely difficult.

Problem Soils

The clay- and mud-bearing bedrock units and unconsolidated deposits, fine-grained rocks associated with some of the cliff-forming formations, and soils derived from them are susceptible to collapse, shrink-swell, piping, and dissolution. Essentially, problem soils develop on all formations stratigraphically above the Salt Wash Member of the Morrison Formation.

Earthquakes

The quadrangle is in a low-risk zone, having a 30% probability of an earthquake greater than magnitude 5.0 within the next 100 years (U.S. Geological Survey, 2007). Inasmuch as the area is uninhabited and few structures (roads, powerlines) exist, potential for damage is low.

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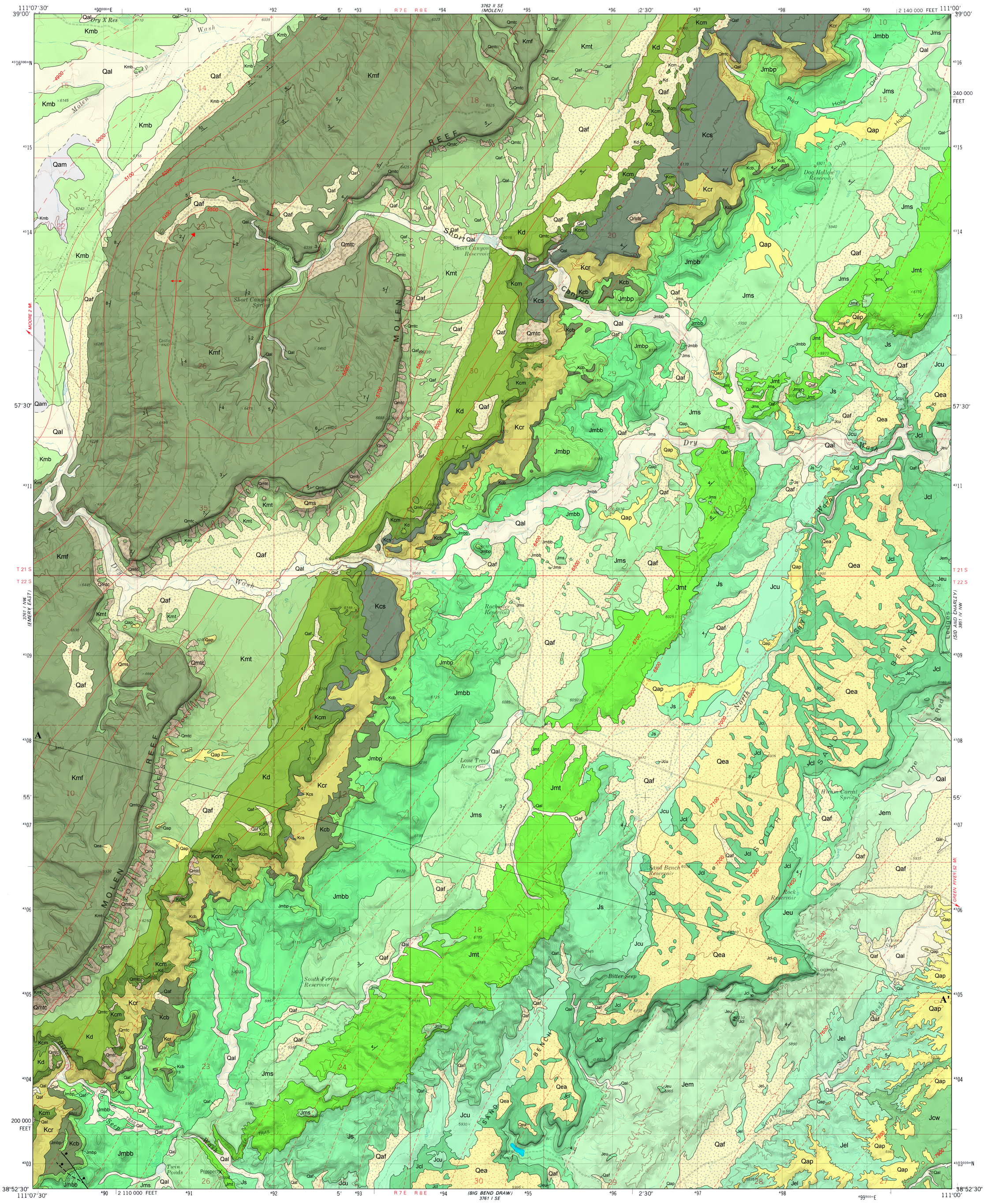

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SCALE 1:24,000

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CONTOUR INTERVAL 40 FEET

10°36′
TRUE NORTH
MAGNETIC NORTH

APPROXIMATE MEAN DECLINATION, 2013

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GEOLOGIC MAP OF THE SHORT CANYON QUADRANGLE, EMERY COUNTY, UTAH

by

Hellmut H. Doelling and Paul A. Kuehne

2013

QUADRANGLE LOCATION

1	2	3
4		5
6	7	8

1. Ferron
2. Molen
3. Horn Silver Gulch
4. Emery East
5. Sid and Charley
6. Mesa Butte
7. Big Bend Draw
8. Copper Globe

ADJOINING 7.5′ QUADRANGLE NAMES

Base from USGS Short Canyon 7.5′ Quadrangle (1983)
Projection: UTM Zone 12
Datum: NAD 1927
Spheroid: Clarke 1886

Project Manager: Grant C. Willis
GIS and Cartography: Paul A. Kuehne and Lori J. Steadman

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DESCRIPTION OF MAP UNITS

Qal **Stream alluvium** (Holocene to Late Pleistocene) – Unconsolidated; poorly to moderately sorted clay, silt, sand, granules, and gravel in stream channels; includes low-level terrace deposits; mostly from local sources; alluvium in the major drainages is mainly Mancos Shale mud interlayered with locally derived very fine grained sand; coarser constituents are commonly interlensed with the finer constituents; includes local colluvium especially south of Short Canyon Spring; uppermost surfaces characterized by weak soil development; upper surfaces adjacent to the main channel are commonly fluted (eroded) by flood waters; as much as 30 feet (9 m) thick.

Qam **Alluvial-mud deposits** (Holocene to late Pleistocene) – Mostly unconsolidated clay, silt, and sand, deposited as fans and mudflows; eroded from Mancos Shale outcrops; form valley fill and mud dominated alluvial fans; locally deeply incised by erosion; unstratified and nearly structureless; as much as 15 feet (5 m) thick.

Qaf **Alluvial-fan deposits** (Holocene to late Pleistocene) – Unconsolidated deposits of poorly sorted, generally unstratified, muddy silt, sand, and gravel; gravel ranges from pebbles to boulders; deposits are locally derived and reflect the source materials; as much as 15 feet (5 m) thick.

Qap **Pediment-mantle deposits** (Holocene to early Pleistocene) – Mostly unconsolidated sand and gravel, but with local silt and boulders, deposited on top of older erosional surfaces; deposits are mostly locally derived and contain angular to rounded pebbles and cobbles from Ferron Sandstone, Dakota Formation, Buckhorn Conglomerate and other ledges in the Cedar Mountain Formation, and Saltwash Member of the Morrison Formation; crudely stratified, mostly matrix supported; as much as 15 feet (5 m) thick, but average 10 feet (3 m) in thickness.

Qms **Landslide and slump deposits** (Holocene to late Pleistocene) – Large coherent blocks to fragmented masses of bedrock and surficial debris transported downslope by mass movement; present along the Molen Reef; debris varies in size from 0.5 to 10 feet (0.2 to 3 m) in diameter; thicknesses vary.

Qmtc **Talus, colluvium, and rock-fall deposits** (Holocene to late Pleistocene) – Generally angular rock-fall blocks, boulders, and small fragments deposited as veneers on slopes below ledges and cliffs; colluvium contains additional slope-wash debris of poorly sorted rock fragments in a sandy matrix; only larger deposits are mapped; mostly present along Molen Reef; thicknesses vary, but average less than 5 feet (1.5 m).

Qea **Mixed eolian and alluvial deposits** (Holocene to Late Pleistocene) – Unconsolidated fine- to medium-grained sand and minor pebble gravel mostly resting on the lower Curtis Formation from which much of the deposits are derived; deposited by sheetwash and wind; present along South Sand Bench; as much as 10 feet (3 m) thick, but mostly less than 5 feet (1.5 m) thick.

Km **Mancos Shale**

Kmb **Blue Gate Member** (Upper Cretaceous, Campanian-Santonian) – Mostly pale blue-gray marine shale, nodular and irregularly bedded mudstone, and siltstone with several yellow-gray, slightly more resistant, sandy beds; mostly a slope former, with sandy beds more common in the lower and upper parts; only lower part is preserved in the northwest corner of the quadrangle, about 300 feet (100 m) is exposed.

Kmf **Ferron Sandstone Member** (Upper Cretaceous, Turonian-Cenomanian) – Alternating yellow-gray, light-brown, and white sandstone, sandy gray shale, gray and carbonaceous shale, and thin coal; mostly fine to medium grained sandstone, commonly calcareous; lenticular, thin to very thick beds; caps the Molen Reef; about 325 feet (100 m) thick, thinning northeastward.

Kmt **Tununk Member** (Upper Cretaceous, Cenomanian) – Medium- to dark-gray marine shale; forms steep slope under Ferron Sandstone cliff; becomes increasingly sandy toward top; has 5- to 10-foot (1.5–3 m) thick Moore sandstone bed that makes a ledge (not mapped) 100 feet (30 m) below the top; about 675 feet (205 m) thick.

Kd **Dakota Formation** (Upper Cretaceous, Cenomanian) – Variable assemblages of yellow-gray sandstone, conglomerate, conglomeratic sandstone, light-brown shale, and coal; sandstone is generally fine to coarse grained, cross-bedded, thick bedded, and lenticular; conglomerate contains gray quartzite and black chert pebbles up to 6 inches (15 cm) across; forms ledges and slopes; local coal beds are generally very thin and bony; 50 to 100 feet (15–30 m) thick.

Kc **Cedar Mountain Formation** – Undivided on cross section. Members are designated from Kirkland and others (1997).

Kcm **Mussentuchit Member** (Upper to Lower Cretaceous, Cenomanian-Albian) – Mostly gray, silty, smectitic mudstone containing a few thin, green-gray, lenticular sandstone beds and some lignitic zones near the top; form smooth rounded slopes; 38 to 110 feet (12–33 m) thick.

Kcs **Short Canyon Member** (informal new name) (Upper to Lower Cretaceous, Cenomanian) – Conglomerate, conglomeratic sandstone, and sandstone ledges, separated by slope-forming sandstone, local gray to black carbonaceous (and possibly coaly) shale, and rare thin gypsiferous sandstone lenses; ledges are cross-stratified, gray, gray brown, and brown, and contain poorly sorted subrounded to subangular grit to cobbles as much as 4 inches (12 cm) across; slope-forming sandstone is mostly light gray or green gray, fine to medium grained, poorly cemented and friable; 0 to 104 feet (0–32 m) thick, and discontinuous, thickening northward in quadrangle.

Kcr **Ruby Ranch Member** (Lower Cretaceous, Albian-Aptian) – Mostly green-gray, light gray, and purple, silty mudstone that contains nodular brown limestone beds; also has a basal muddy sandstone bed; locally contains a few lenticular ledges of fine-grained, locally pebbly sandstone, especially at base; brown limestone ledges commonly break up and litter the smooth slopes; 76 to 131 feet (23–40 m) thick.

Kcb **Buckhorn Conglomerate Member** (Lower Cretaceous, Barremain-Aptian?) – Gray-brown conglomerate, conglomeratic sandstone, and sandstone; contains pebble- and cobble-sized clasts of quartzite, chert, and black siliceous limestone in a matrix of poorly sorted, fine- to coarse-grained sandstone interbedded with gray-green silty and sandy shale; sandstone is trough cross-bedded, lenticular, and discontinuous; forms ledges and benches that are channeled into the underlying purple unit of the Brushy Basin Member of the Morrison Formation; mapped only where the outcrops form benches; is included with the Ruby Ranch Member (Kcr) where thin or less well developed; 0 to 40 feet (0–12 m) thick.

Jm **Morrison Formation**

Jmb **Brushy Basin Member** – Undivided on cross section.

Jmbp **Purple unit** (Upper Jurassic, Tithonian) – Mostly light purple to light pink gray siltstone and mudstone; commonly forms two steep slopes separated by a persistent ledge of sandstone and conglomerate; contains many horizons of brown limestone nodules that break up and litter slopes; 80 to 120 feet (25–35 m) thick.

Jmbb **Brightly banded unit** (Upper Jurassic, Tithonian) – Mudstone with clay, silt, and fine-grained sandstone, banded in shades of light gray, light brown, or light purple; mudstone is commonly bentonitic; also contains scattered horizons of brown limestone nodules, thin white sandstone beds, and lenticular conglomeratic beds; forms steep slopes with local ledges; 205 to 265 feet (60–80 m) thick.

Jmst **Salt Wash and Tidwell Members**, undivided – on cross section only.

Jms **Salt Wash Member** (Upper Jurassic, Kimmeridgian) – Gray conglomeratic sandstone and interbedded green-gray, purple, and light gray mudstone and siltstone; forms slopes, cliffy ledges and benches; 95 to 225 feet (30–70 m) thick, thickening irregularly northward.

Jmt **Tidwell Member** (Upper Jurassic, Kimmeridgian) – Red-brown, locally mottled siltstone and subordinate very fine-grained, platy-weathering sandstone interbedded with gypsum beds; light- to medium-gray, medium- to coarse-grained sandstone beds are locally present in the basal part to lower half of the unit; many siltstone beds contain flattened blebs and lozenges of pink gypsum; 70 to 90 feet (20–25 m) thick; gypsum beds are as much as 14 feet (4.3 m) thick.

Js **Summerville Formation** (Upper Jurassic, Oxfordian) – Light- to dark-brown and subordinate white or light-gray, thin and evenly bedded siltstone and very fine-grained sandstone; forms convex slopes; 255 to 295 feet (80–90 m) thick.

Jc **Curtis Formation** – Undivided on cross section.

Jcu **Upper member** (Upper Jurassic, Oxfordian) – Green-gray and subordinate light-brown, fine-grained sandstone forming a series of slopes divided by thin ribs of more resistant sandstone; mostly thin-bedded; becomes finer-grained and less resistant in upper part; 85 to 100 feet (26–30 m) thick.

Jcl **Lower member** (Upper Jurassic, Oxfordian) – Light-gray to light green-gray, fine-grained, thin-to thick-bedded, calcareous sandstone; most beds are cliffy and ledgy and weather into thick slabs; lower quarter is green-gray siltstone and mudstone that forms a slightly recessed vertical cliff or a steep slope; a few thin pebbly or gritty beds are commonly found in the lower quarter; 95 to 105 feet (29–32 m) thick.

Je (Jeu, Jem, Jel) **Entrada Sandstone upper, middle, and lower members** (Middle Jurassic, Callovian) – Undivided on cross-section only. Overall, formation is orange-brown to brown silty sandstone and subordinate siltstone; sandstone is very fine to fine grained with scattered medium or coarse grains; thin bedded to massive or indistinctly bedded; weathers into cliffs, ledges and earthy slopes. Divided into three informal members: upper member (Jeu) commonly stands as a cliff and has a basal white fine-grained sandstone marker bed at its base; middle member (Jem) consists of alternating ledges and thin-bedded earthy slopes; lower member (Jel) forms mostly earthy slopes, has indistinct bedding, and contains abundant gypsum in thin beds and satin-spar veinlets; Je is about 705 feet (215 m) thick; Jeu is about 155 feet (45 m) thick, Jem is about 255 feet (80 m) thick, and Jel is about 295 feet (90 m) thick.

Jcw **Carmel Formation, Winsor Member** (Middle Jurassic, Bathonian-Callovian) – Mostly siltstone interbedded with calcisiltite, calcarenite, and gypsum; mostly green gray and red brown; criss-crossed with satin-spar gypsum veinlets; mostly forms steep earthy slopes littered with platy calcarenite or calcisiltite; only upper 50 feet (15 m) exposed in the quadrangle.

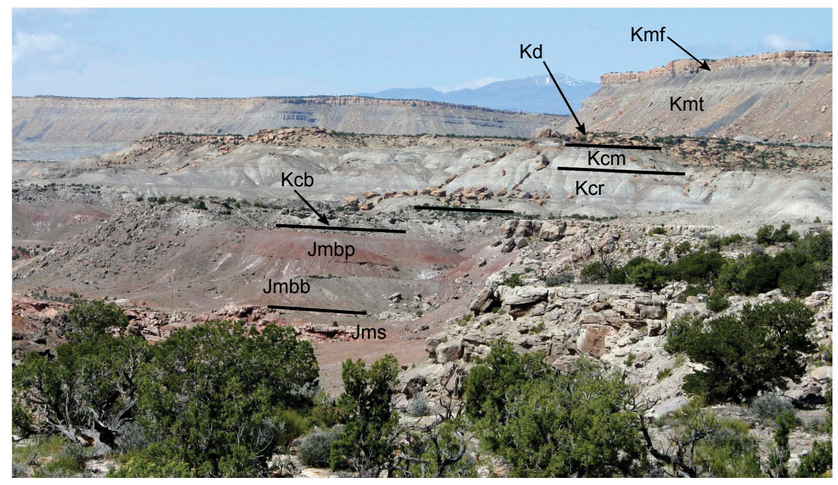


Figure 1. View to the southwest near Short Canyon of the Salt Wash Member of the Morrison Formation to the Ferron Sandstone Member of the Mancos Shale. The Short Canyon Member of the Cedar Mountain Formation is not present in this view.

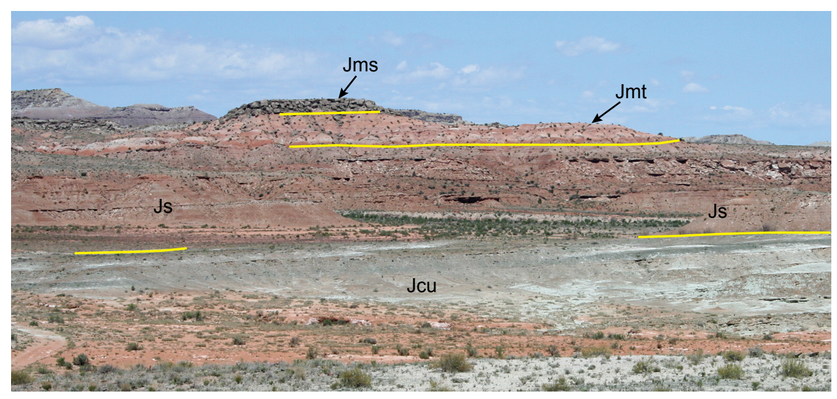
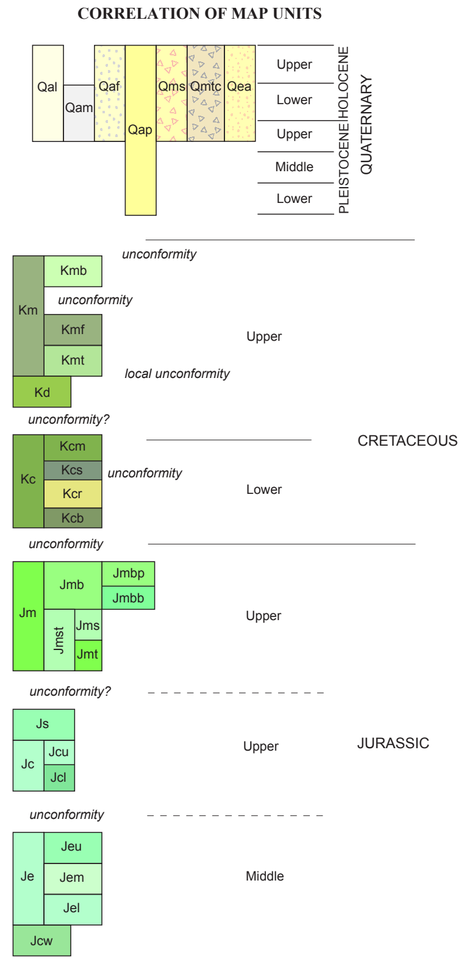
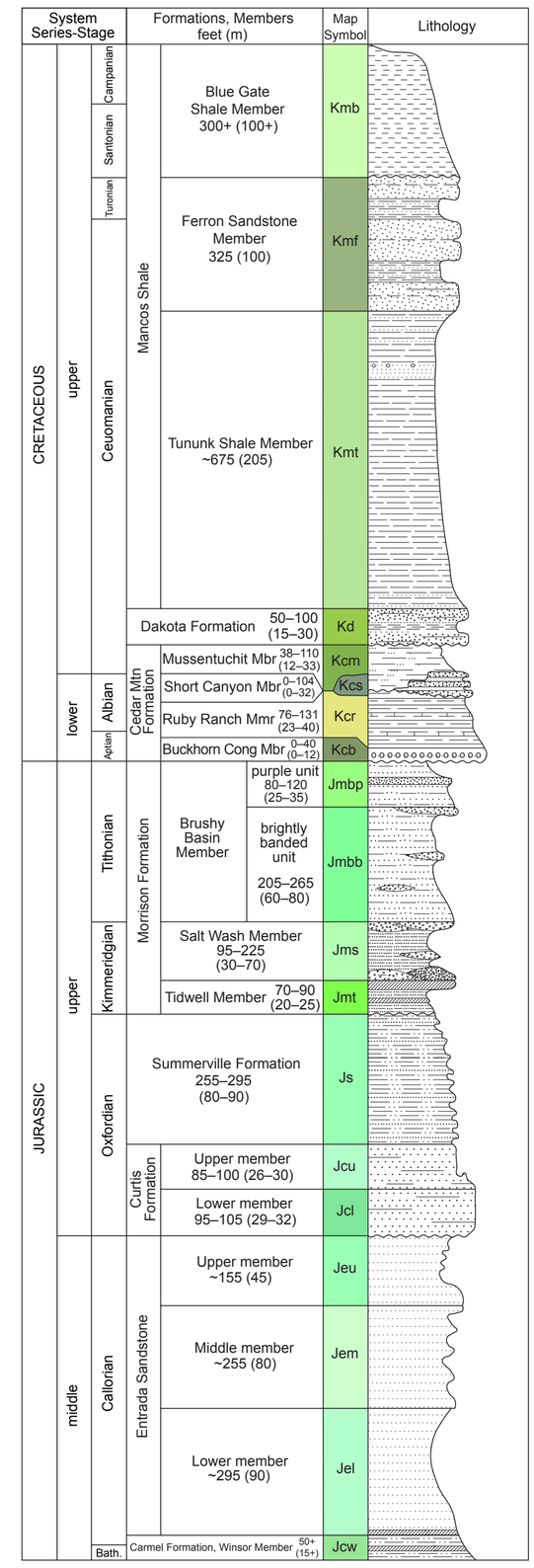


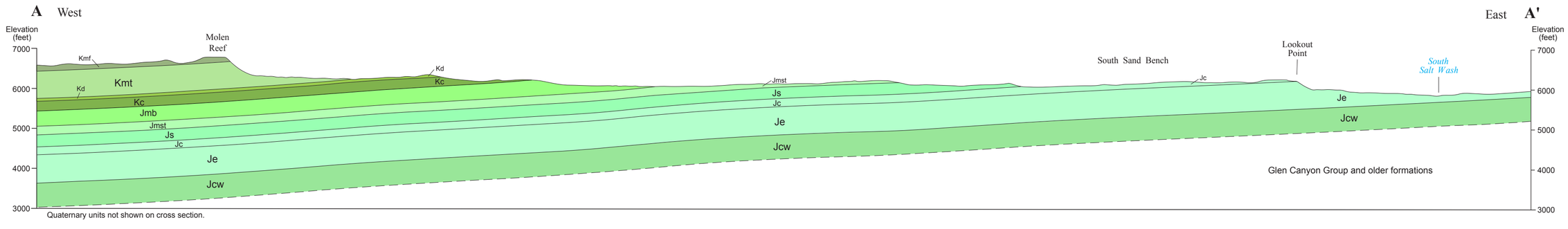
Figure 2. View of the upper member of the Curtis Formation, Summerville Formation, and the Tidwell and Salt Wash Members of the Morrison Formation. View to the east near North Salt Wash.

CORRELATION OF MAP UNITS



LITHOLOGIC COLUMN



MAP SYMBOLS

- Contact – dashed where gradational or approximate
- Normal fault – Bar and ball on downthrown side; dashed where approximately located
- Structure contour – contour interval 100 feet, drawn on base of Dakota Formation; short dash where contour is projected above ground surface; long dash where approximate (5500)
- Anticlinal axis – showing plunge
- Synclinal axis – showing plunge
- A — A' Line of cross section
- 12 Strike and dip of inclined bedding
- Spring
- Prospect