Kitzmiller II - Joes Valley Reservoir Quadrangle

PRELIMINARY GEOLOGIC MAP OF THE JOES VALLEY RESERVOIR QUADRANGLE,

Emery and Sanpete counties, Utah

John M. Kitzmiller II

UTAH GEOLOGICAL AND MINERAL SURVEY
a division of the
Utah Department of Natural Resources and Energy

TO ACCOMPANY MAP 67 JULY 1982

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John M. Kitzmiller II[1]

INTRODUCTION

Joes Valley Reservoir quadrangle lies on the eastern side of the Wasatch Plateau in Emery and Sanpete counties. Drilling activity for coal has proceeded to the east edges of the area. Interest in expanding the Wasatch Plateau coal field reserve base has prompted this more detailed investigation of the surface geology in the quadrangle (Kitzmiller II, 1981).

STRATIGRAPHY

General

Rocks in the Joes Valley Reservoir quadrangle total approximately 2,100 meters (6,890 feet) and consist of inter-bedded sandstone, limestone, shale, mudstone, and conglomerate. The exposed units include the Upper Cretaceous Blackhawk Formation, Castlegate Sandstone, Price River Formation, the Upper Cretaceous and Paleocene North Horn formations, and the Paleocene Flagstaff Limestone. Coals occur in both the North Horn and Blackhawk formations, but only those of the Blackhawk are of economic significance. However, the coals of the Blackhawk are not exposed, since only the upper part of the formation crops out in the quadrangle. Quaternary deposits include moraines, colluvium, alluvium, alluvial fans, and landslide debris. These surficial deposits are extensive in the major valleys and cover many of the slope-forming units.

Cretaceous System

Blackhawk Formation – The Blackhawk is the oldest unit exposed on the quadrangle and consists of sandstone, muddy sandstone, siltstone, shale, and shaly sandstone. The crossbedded sandstone units range in thickness from thin- to thick-bedded, and are composed of very fine- to medium-grained quartz and chert grains. The predominant quartz and minor black chert grains are rounded, spherical, polished, and well-sorted. Sandstone beds range from moderate yellow-brown to light grayish orange and are well cemented with calcite and limonite, and sandstone layers form cliffs, ledges, and ledgy slopes.

The interbedded muddy sandstone is generally thin- to medium-bedded and usually soil covered, but where exposed forms low ledges. These rocks are predominantly quartz and are moderate yellow-brown to light grayish-orange.

The siltstone, shale, and shaly sandstones form slopes that are usually covered by soil. These beds range from medium light-gray to grayish-orange, and are thin-bedded to laminated. Fossil plant material is locally abundant in the upper Blackhawk beds, but no forms could be specifically identified.

The base of the Blackhawk Formation is not exposed and only the upper 160 meters (525 feet) could be measured. The formation is 230 to 328 meters (755-1076 feet) thick in the coal-mining areas (eastern part of the Wasatch Plateau). There the base is conformable on the littoral marine Star Point Sandstone and the coals occur in the lower 60 meters (197 feet) of the unit. The upper contact is at the base of the massive cliff-forming Castlegate Sandstone. This contact is well-exposed from Sec. 16, T. 17 S., R. 6 E., along the east-bounding scarp of lower Joes Valley to Sec. 5, T. 18 S., R. 6 E. The upper part of the Blackhawk is well exposed on both sides of the Joes Valley graben beneath the Castlegate cliffs.

Castlegate Sandstone – The Castlegate Sandstone forms prominent cliffs in the Joes Valley Reservoir quadrangle, and is easily traced along fault scarps of Lower Joes Valley and eastward in walls of Straight Canyon. Exposures are covered south of Reeder Canyon and poor south of Straight Canyon. It is usually thick bedded and massive, with thin crossbed sets and channel fills. The sandstone usually weathers to moderate yellow to dark yellowish orange and is composed of fine- to medium-grained quartz that is well cemented with calcite and limonite. The sandstone grains are spherical, polished, and well sorted. Limonite concretions and plant impressions are common and conglomerate lenses occur throughout. Trace fossils can be found in the unit and are small labyrinth castings like those described by Howard (1966, p. 44-45).

Two measurements of the Castlegate indicate a thickness ranging from 88.4 meters (290 feet) to 106.4 meters (349 feet). A distinctive quartzite- and chert-pebble conglomerate occurs at the top of the Castlegate Sandstone and was used as the upper contact of the formation and was mapped on both sides of the north half of Lower Joes Valley. It is gradational with Price River beds. Where this pebble conglomerate was not observed, the contact was mapped on top of a cliff-forming unit below an overlying shale. The lower con-

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tact lies immediately above a shale layer of the Blackhawk Formation and is unconformable.

Price River Formation – This unit is widey exposed throughout the quadrangle but is largely mantled by debris from the North Horn Formation south of Straight Canyon. The formation consists of sandstone, grit, conglomerate, and shale. Sandstone beds are generally ledge or cliff-formers and vary from moderate yellow and yellow-brown to grayish orange and are composed of fine- to medium-grained quartz. Grains show signs of re-working and they are rounded, spherical, and polished. Calcite is the main cement and beds vary from well cemented in some, to poorly cemented in others. There is a higher percentage of chert and intraclasts in the poorly cemented sandstones, which also have greater porosity.

Slopes of the formation are generally formed on thin-bedded, poorly cemented sandstones with small crossbed sets or on thin, orange-brown mudstones. The ledgy slope-forming and cliff-forming beds are medium- to thick-bedded sandstone that is usually well cemented and is cross-bedded. These sandstones are channel-filled, have conglomeratic lenses in channel-bottoms, and contain large ripples.

The Price River Formation can be divided into an upper and lower member. The lower is a resistant ledge- and cliff-former 120 meters (394 feet) thick and the upper is a slope-former 90 meters (295 feet) thick. The lower member contains invertebrate fossils, fish scales, and petrified wood. Identifiable fauna include *Sphaerium subellipticum* Meek and Hayden (pelecypod) and *Vitrina* sp. Meek and Hayden (gastropod). The lower member overlies the Castlegate Sandstone conformably. A thin shale unit about one half to one meter thick occurs between the massive Castlegate cliffs and the formation on the eastern side of Lower Joes Valley. This shale was used as the lower contact in the eastern exposures, but when covered, formation limits were inferred on the basis of erosional profile, thickness of the formation, and position with reference to beds of the North Horn Formation.

The upper contact was mapped on top of a medium- to thick-bedded cliff-forming sandstone. A slope and bench-forming unit of interbedded sandstone, shale, and limestone occurs above this resistant unit and was assigned to the North Horn Formation. The upper contact is usually gradational and upper Price River beds are difficult to distinguish from North Horn beds in isolated exposures.

Cretaceous-Tertiary System

North Horn Formation – This unit consists of sandstone, conglomerate, shale, mudstone, and limestone. It is exposed on both sides of Lower Joes Valley and in small hills in the valley floor. The terraced uplands below the cliff-forming Flagstaff Limestone are formed on the North Horn Formation. Four informal members were mapped in the Joes Valley Reservoir quadrangle, lettered A through D. Member A is sandstone with interbedded conglomerate and limestone and forms gentle slopes above the Price River Formation. The member is about 125 meters (410 feet) thick. The sandstone beds are largely grayish to yellowish gray, and are composed of very fine- to medium-grained quartz grains that are well sorted, rounded, spherical, and polished. The rocks are fair- to well-cemented by calcite. Limestones of Member A weather to various shades of gray. They are generally finely crystalline to micritic and are only slightly fossiliferous. Most fossils are gastropods and are fragmental. Member A is mainly fluvial but also contains a lacustrine facies.

Member B is approximately 113 meters (371 feet) thick and is composed of medium- to thick-bedded sandstone that weathers dark yellowish orange or yellowish gray to very pale orange. The sand is fine grained quartz and grains are rounded, spherical, polished and well sorted. The rocks are well cemented with calcite. Member B is strongly jointed and weathers to angular blocks. Unit 2 on North Horn Mountain was considered to be mainly lacustrine by Spieker (1946, p. 133), but Member B in the Lower Joes Valley area is mainly fluvial.

Member C comprises the major part of the bench in Sec. 26, T. 17 S., R. 5 E., and forms a gentle slope. The unit is approximately 115 meters (377 feet) thick, and consists of limestone and sandstone. The base of the member is a grayish brown micritic limestone that has a few gastropod fossils. It contains some mud intraclasts and grades up into a dark gray bioclastic limestone with abundant gastropods. This grades up into a second tan micritic limestone that has abundant gastropods and intraclasts. This is overlain by the sandstone that comprises the rest of Member C. This sandstone is very light gray, grayish orange-pink, or very pale orange, and weathers to grayish orange. It is very fine-grained except near the top of the unit where it is coarse-grained. The grains are predominantly quartz with some black chert. They are round, spherical, polished, and well sorted. The sandstone beds are fairly well cemented with calcite but many have good porosity. This member appears to be transitional between floodplain and lacustrine environments.

Member D is well exposed throughout the western half of the quadrangle where it forms steep reddish slopes beneath the light gray cliffs of the Flagstaff Limestone. In places it consists of variegated shales and

mudstones that are particularly well exposed at Clay Bank and along Wagon Road Ridge. Member D is approximately 130 meters (427 feet) thick and is mostly evenly bedded sandstone and conglomeratic sandstone, very light gray or pale pink to light olive gray or pale pink. Sandstone beds are medium- to coarse-grained and comprised of quartz and black chert grains that are rounded, spherical, and polished, but the rocks also include 20% to 30% mud rip-up clasts. These beds range from poor- to well-cemented with calcite and limonite.

Fossils were collected from the North Horn in Sec. 16, T. 17 S., R. 5 E., in Littles Canyon, include *Unio* sp., *Viviparus* sp., *Viviparus* (?) *prudentius* White, *Bulinus*, sp., and *Helix*, sp. Specimens collected at Birch Spring at the northern end of North Horn Mountain are identified as *Unio* (?) *vestustus* Meek, *Bulinus longinsculus* Meek and Hayden, *Viviparus* (?) *prudentius* White, *Goniobasis* (?) *tenuicarinata* Meek and Hayden and *Cassiopella turricula* White.

The upper contact of the formation was placed near the abrupt color change between the gray cliff-forming Flagstaff Limestone and the red and variegated steep slope-forming North Horn beds. This contact is very well exposed at Clay Bank, and less exposed in Olsen Canyon, Ridley and Wagon Road ridges. Where the color difference was not seen, the upper contact was mapped on the basis of slope change.

Tertiary System

Flagstaff Limestone – Throughout the Wasatch Plateau, the Flagstaff Limestone forms a resistant cap and on this quadrangle it caps Clay Bench, Olsen Bench, Ridley and Wagon Road ridges. LaRocque (1960, p. 12) reported that three basic lithologic units make up the Flagstaff on the west slopes of the Wasatch Plateau. The lower two of these can be identified in the Joes Valley Reservoir quadrangle. The lower member (Member A) is about 117 meters (384 feet) thick at Clay Bank and it in turn can be divided into submembers. The lowermost subunit consists of alternating micritic limestone and wackestone in beds up to 30 centimeters (12 inches) thick interbedded with shale like that which occurs at the base of the formation. This lower unit is a slope and ledgy-slope former. The middle unit is alternating blocky micrite and wackestone that occur in beds up to one half of a meter thick, and is interbedded with shale. This unit forms ledgy slopes and vertical cliffs. The upper unit is like the lower unit in both lithology and slope characteristics.

The upper member (Member B) could not be measured because it forms vertical cliffs. The estimated thickness ranges from 140 to 250 meters (459-820 feet) in the mapped area. The limestone weathers milky-white to cream, contains few fossils, and exhibits much stylolitic bedding. The unit further contains abundant chert nodules and tufa. This upper member is exposed on Olsen Bench and Wagon Road Ridge.

Gastropods and pelecypods are the most abundant fossils in the Flagstaff Limestone, with gastropods being the most numerous. Specimens were collected from outcrops on the hill near Miller Flat at Sec. 17, T. 17 S., R. 6 E., and from the top of Clay Bench. Fossils from the Miller Flat locality include *Physa bridgerensis* Meek and Hayden, and *Viviparus trochiformis* Meek and Hayden. No pelecypods were found at this outcrop. Collected fossils from Clay Bench locality are (in decreasing order of abundance): *Viviparus trochiformis* Meek and Hayden, *Lioplacodes mariana* Yen, *Elliptio (Plesielliptio mendax)* White, and *Physa sp.* The contact between the Flagstaff Limestone and the North Horn Formation is well exposed at Clay Bank, Sec. 15, T. 17 S., R. 5 E., at Ridley Ridge just outside the quadrangle to the west, and at Sec. 10, T. 17 S., R. 5 E., on Wagon Road Ridge. The contact was mapped at the base of the gray limestone and shale of the Flagstaff Limestone, and above the red to gray mudstones at the top of the predominately red upper unit of the North Horn Formation. The Flagstaff Limestone intertongues regionally with the North Horn Formation, below, and with the Colton Formation above.

Quaternary System

Quaternary deposits in the Joes Valley Reservoir quadrangle are located throughout the area and include alluvial fans, alluvium, colluvium, landslide debris, and morainal debris. Alluvial fans, alluvium, and colluvium appear predominately in the low elevation, semi-arid Lower Joes Valley. Decreased rainfall, due probably to the valley's lower elevation, restricts erosional processes to those requiring less water. A large well-developed alluvial fan occurs at Sec. 29, T. 17 S., R. 6 E. Other alluvial fans occur along the steep slope change on both sides of Lower Joes Valley. The alluvial fans are usually composed of clay and sand, with occasional small sandstone blocks near the apex of the fan.

Alluvium is confined to some of the stream channels of the canyons in the area and within the valley floor of Lower Joes Valley. The alluvium in the stream channels is mostly pebble- to cobble-size in such streams as North Dragon Creek, Seely Creek, Littles Creek, Reeder Creek, Lowry Water, and Indian Creek. Fine-grained sand and clay is predominant in Lower Joes Valley.

Colluvium is mostly located along the Joes Valley fault and Reeder Ridge fault and forms the steep slopes that occur between the Castlegate Sandstone cliffs,

Blackhawk Formation, and the floor of Lower Joes Valley. The composition of the colluvium is a mixture of fine-grained sand and clay with frequent sandstone blocks that range from pebble size and larger. A small deposit of colluvium is located at the SE¼ of Sec. 19, T. 17 S., R. 6 E., which was shed from the hill just to the east.

Slumping is active throughout the area and landslides were mapped separately. Most landslides are heavily vegetated and noticeable only by geomorphic expression. Many of the landslides could be mudflows. Landslide deposits occur in Littles and Reeder canyons at the east fronts of Olsen and Clay benches, and along the fault scarps of Lower Joes Valley. They are composed of clay and mud with occasional larger clasts, generally all of which are derived from the North Horn Formation.

Morainal deposits are located throughout the quadrangle. Major deposits occur in Seely and Reeder canyons with minor amounts in Littles Canyon. Large moraine deposits occur at the mouths of Seely, Littles, and Reeder canyons that dammed parts of Lower Joes Valley. These deposits range to 40 meters (131 feet) in thickness and cover most of Sec. 19 and 31, T. 17 S., R. 6 E. Morainal surfaces in the quadrangle are hummocky and irregular with occasional small depressions or kettles. The till is composed of small to large angular blocks to two meters in diameter of locally derived sandstone and limestone, all embedded in a matrix of unstratified sand and clay.

STRUCTURE

The structural pattern in the Joes Valley Reservoir quadrangle is dominated by a north to northeast-trending system of faults that interrupt gentle northwest-southeast-trending synclines, anticlines, and monoclines, or the nearly flat rocks of the plateau. Hunt (1956, p. 53) attributed the north-trending faults of the plateau to a zone transitional between the Colorado Plateau and the Basin and Range provinces.

Rocks in the eastern part of the quadrangle are broken by high-angle normal faults like those that define the Joes Valley graben. Smaller faults split from, or trend parallel to, the main boundary faults and secondary antithetic systems, and form grabens. The Joes Valley fault zone is a north-south trending graben that is mappable as a distinct structure for approximately 75 miles. The zone is approximately two miles wide and is traceable through the Joes Valley Reservoir quadrangle. The eastern boundary fault of the graben is a high-angle fault that is traceable within the quadrangle from Sec. 4, T. 17 S., R. 6 E. to Sec. 17, T. 18 S., R. 6 E., and is here named the Joes Valley fault. This fault has produced an imposing west-facing scarp with displacement deepening southward. Displacement of approximately 630 meters (2,067 feet) has occurred in Sec. 9, T. 17 S., R. 6 E., where North Horn beds of Unit 1 abut upper Blackhawk beds. A displacement of 701 meters (2,300 feet) was measured on the fault in Section 20, T. 17 S., R. 6 E. (Davis and Doelling, 1977, p. 177, p. 9), where Member A Flagstaff beds abut upper Blackhawk beds. A displacement of about 902 meters (2,960 feet) is documented in Sec. 8, T. 18 S., R. 6 E., where beds of Flagstaff Limestone Unit 2 abut upper Blackhawk beds.

The western boundary fault of the major graben is separable into two major high-angle normal fault segments north and south of Sec. 25, T. 17 S., R. 5 E. The southern of these is here named the Water Terrace fault and is traceable from Sec. 18, T. 18 S., R. 6 E., to Sec. 5, T. 17 S., R. 5 E. Elsewhere the fault trace is concealed by colluvium or alluvium, but a lineament is observable on aerial photographs near the blanketed escarpment. Displacement is estimated to be approximately 900 meters (2,953 feet). The northern segment is here named the Reeder Ridge fault. It is traceable from Sec. 36, T. 17 S., R. 5 E., northward to the quadrangle border. This fault forms an imposing east-facing scarp from the mouth of Reeder Canyon northward. Displacement is estimated to be 660 meters (2,165 feet) in Sec. 19, T. 17 S., R. 6 E., 540 meters (1,772 feet) in Sec. 18; and 475 meters (1,558 feet) at Sec. 7. It shows the same pattern or southward increase in displacement as seen on the Joes Valley fault along the east side of the graben.

The Joes Valley fault, the Reeder Ridge fault, and the southern part of the Water Terrace fault define a section of the Joes Valley fault zone here named the Lower Joes Valley graben. The graben interrupts the gentle west- and southwest-dipping rocks of the Wasatch Plateau. Strata maintain a regional strike to the northwest on both sides of the post-Flagstaff graben. This suggests that the Lower Joes Valley graben is an extensional feature that interrupts the pattern of broad, gentle folding of the Wasatch Plateau (Stokes, 1956, p. 790).

The Wilberg fault named here, parallels the Reeder Ridge fault. It is mappable from Sec. 30, T. 17 S., R. 6 E. northward to beyond the quadrangle boundary. For the most part, the fault is concealed but was mapped on the basis of geomorphic expression and lineaments on aerial photographs. This fault is significant in dating movement within the graben, for it displaces Pleistocene moraines on the Wilberg Ranch in northeast part of Sec. 7, and in the east half of Sec. 6 in T. 17 S., R. 6 E. Interruption of the moraine indicates post-Pleistocene to Recent movement. Displacement is assumed to be

consistent in style and amount with the Reeder Ridge fault.

The Olsen fault is named here for a southward splinter of the Water Terrace fault. This fault trace is also concealed for the most part but is mappable as a lineament on aerial photographs. This fault does have surface expression at Olsen Ranch, in the east half of Sec. 7 and 18 of T. 17 S., R. 6 E. Here the Olsen fault and the Water Terrace fault define a small horst of the North Horn Unit 2 and 3 beds. A large spring at the eastern base of this horst marks the trace of the Olsen fault. Olsen and Water Terrace faults define another small horst of North Horn Unit 3 and 4 beds in Sec. 19, T. 17 S., R. 6 E.

Dragon Ridge is a small horst of lower Flagstaff and North Horn Unit 4 beds that extends from Sec, 7, T. 18 S., R. 6 E., southward out of the quadrangle. The fault that bounds the east side of the horst is here named the Dragon Ridge fault. Several small parallel faults on the west side of Dragon Ridge are largely concealed but are mappable as lineaments.

Middle Mountain is a large prominent horst that is bounded on the west by the combined Water Terrace and Olsen faults and on the east by the Joes Valley fault. Rocks exposed on Middle Mountain include uppermost Price River beds to the lower part of North Horn Unit 3. The bounding faults at Middle Mountain are high-angle reverse faults.

Additional small horsts were mapped in several segments of the major graben. One in Sec. 18, T. 17 S., R. 6 E., is composed of North Horn Unit 3 beds. A horst in Sec. 17 and 20, T. 17 S., R. 6 E., is composed of middle Flagstaff Limestone and North Horn Unit 4 sandstone. A third small horst in Sec. 8, T. 18 S., R. 6 E., is composed of middle Flagstaff beds.

A northwest-trending monoclinal fold dominates the northwest quarter of the Joes Valley Reservoir quadrangle. This trend parallels other structural features of the Wasatch Plateau.

ECONOMIC GEOLOGY

Coal is the main economic deposit in the Wasatch Plateau and occurs as several thick beds in the lower Blackhawk Formation. The Joes Valley Reservoir quadrangle is within the boundaries of the Wasatch Plateau coal field but here only upper beds of the Blackhawk Formation are exposed. A few thin carbonaceous shales and bony coals are present in lacustrine units of the North Horn Formation. A thin coal bed, about 91 centimeters (3 feet) thick, is located approximately 91 meters (300 feet) below the base of the Castlegate Sandstone in Dry Basin but has limited economic potential. Little is known about the economic seams in the lower part of the Blackhawk. The Utah Geological and Mineral Survey has drilled coal exploration holes less than a mile east of the quadrangle boundaries. Coal in the important Hiawatha bed persists to the edge of the Joes Valley fault zone and this thickness may extend under the quadrangle.

The petroleum potential of the quadrangle has been untested. Production was developed in the Upper Joes Valley area to the north (T. 15 S., R. 6 E.) but there has been no drilling in the present quadrangle. There is some potential for oil and gas in the "Black Canyon Dome" (Kucera, 1970, pp. 176-178), just north and northwest of the study area. That structural feature is also suggested as extending a short distance into the quadrangle from the north.

Several good quarry sites for road metal occur within the quadrangle and have easy access. They could provide road metal for use in the quadrangle and for roads at higher elevations to the west. One such potential site is at Bub's Creek in Sec. 18, T. 18 S., R. 6 E., where down-faulted Flagstaff beds are exposed with easy access from a Forest Service unimproved road. Another is in the east half of the southwest ¼ of Sec. 19, T. 17 S., R. 6 E., near the mouth of Reeder Canyon. Here limestone beds occur in a down-faulted block of North Horn Unit 3 and 4 beds with easy access from Highway 29. Flagstaff beds are also exposed in the small horst at Sec. 17, T. 17 S., R. 6 E., with easy access from the road at Miller Flat.

There are good sources of water on the quadrangle, including several perennial streams. Most of the water eventually flows into the Joes Valley Reservoir, which has a storage capacity of 54,610 acre feet. Alternating permeable and impermeable beds of the North Horn Formation control numerous small springs throughout the quadrangle and help recharge the reservoir. Some of these are tapped by local ranchers. Outcrops of the Price River Formation and Castlegate Sandstone also have numerous springs. The Blackhawk Formation has few springs and most of those are saline. Many springs are controlled by faults. For example, Birch Spring in Sec. T. 18 S., R. 6 E., and the spring at Olsen Ranch southeast ¼, Sec. 7, T. 17 S., R. 6 E., owe their location to fault control.

Most of the land in the Joes Valley Reservoir quadrangle is in the Manti-La Sal National Forest, and as such provides a significant scenic and recreational resource for the area. Woodland and mountain pastures, lakes, reservoirs, campsites, and permanent streams are present in the western and northern parts of the quadrangle. The area also has a potential for winter sports.

REFERENCES CITED

Davis, F. D., and Doelling, H. H., 1977, Coal Drilling at Trail Mountain, North Horn Mountain, and Johns Peak Area, Wasatch Plateau, Utah: Utah Geological and Mineralogical Survey, Bulletin 112, 90 p.

Howard, J. D., 1966, Characteristic Trace fossils in Upper Cretaceous sandstones of the Book Cliffs and Wasatch Plateau *in* Central Utah Coals: A guidebook prepared for the Geological Society of America and Associated Societies: Utah Geological and Mineralogical Survey, Bulletin 80, pp. 35-53.

Hunt, C. B., 1956, Cenozoic geology of the Colorado Plateau: U. S. Geological Survey Professional Paper 279, 99 p.

Kitzmiller II, H. M., 1981, Joes Valley Reservoir Quadrangle Emery and Sanpete counties, Utah: Unpublished Masters thesis, Brigham Young University.

Kucera, R. E., 1970, Geology of the Joes Valley and North Dragon area, central Utah: Utah Geological and Mineralogical Survey, Bulletin 86, *also* Masters thesis, Ohio State University, 20 p., 1954.

Spieker, E. M., 1946, Late Mesozoic and early Cenozoic history of central Utah: U. S. Geological Survey Professional Paper 205-D, p. 117-161.

Stokes, W. L., 1956, Tectonics of the Wasatch Plateau and nearby areas (Utah) (abstract): American Association of Petroleum Geologists, Bulletin, v. 40, no. 4, p. 790.

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MAP 67
PRELIMINARY GEOLOGIC MAP OF THE JOES VALLEY RESERVOIR QUADRANGLE SANPETE AND EMERY COUNTIES, UTAH

SYSTEM	SERIES	FORMATION	SYMBOL	LITHOLOGY	THICKNESS IN FEET (METERS)	DESCRIPTION
QUATERNARY		Unconsolidated deposits	Qal, Qc, Qf, Qls, Qm		0-66+ (0-20+)	alluvium, colluvium, alluvial fans, landslide deposits, and moraines
					460+ (140+)	limestone, white, with minor light colored shale, channel sandstone, gypsum and chert
TERTIARY	Paleozoic	Flagstaff Limestone	Tfb		385 (117)	shale and limestone, dark blue-gray, thin-bedded
			Tfa			
		North Horn Formation	TKnd		427 (130)	sandstone, conglomeratic sandstone, light gray, olive gray or pale pink, medium to coarse-grained, locally has variegated shales and mudstones
			TKnc		377 (115)	limestone, micritic gray brown to tan and fossiliferous in lower part, sandstone, light gray, gray-orange pink or pale orange, mostly fine-grained, and calcareous
			TKnb		371 (113)	sandstone, dark yellow orange weathering, medium to thick-bedded, and fine-grained, weathers to angular blocks
			TKna		410 (125)	sandstone, gray to yellow gray, fine- to medium-grained interbedded with conglomerate and gray limestone
UPPER CRETACEOUS		Price River Formation	Kpu		295 (90)	sandstone, yellow to yellow-brown, fine- to medium-grained, generally thin-bedded and poorly cemented, slope forming, with an occasional ledge-forming thick bedded sandstone
			Kpl		394 (120)	sandstone, yellow to yellow brown, fine- to medium-grained, medium to thick-bedded, well cemented, crossbedded, ledge-forming with some shaly interbeds
		Castlegate Sandstone	Kc		328 (100)	sandstone, yellow to dark yellowish orange weathering, fine- to medium-grained, calcareous, forms prominent cliffs
		Blackhawk Formation	Kb		525 (160)	interbedded sandstone, muddy sandstone, siltstone, shale, shaly sandstone, shaly to thickbedded, contains coal-beds in the unexposed subsurface (not shown), generally slope forming

EXPLANATION

QUATERNARY
- Qal — Alluvium
- Qc — Colluvium
- Qf — Alluvial fan
- Qls — Landslide deposit
- Qm — Moraine

TERTIARY
- Tfb — Flagstaff Limestone, micritic limestone member
- Tfa — Flagstaff Limestone, bioclastic limestone member
- TKnd — North Horn Formation, variegated shale - mudstone member
- TKnc — North Horn Formation, limestone - sandstone member
- TKnb — North Horn Formation, sandstone member
- TKna — North Horn Formation, sandstone - limestone member

UPPER CRETACEOUS
- Kpu — Price River Formation, upper slope member
- Kpl — Price River Formation, lower resistant member
- Kc — Castlegate Sandstone
- Kb — Blackhawk Formation

SYMBOLS

- Contact — *Dashed where approximately located; dotted where inferred*
- Normal fault — *Dashed where approximately located; dotted where concealed.* U, *upthrown side;* D, *downthrown side*
- Strike and dip of beds
- Anticline — *Showing trace of axial plane*
- Syncline — *Showing trace of axial plane*
- Structure Contours — *Drawn on top of Blackhawk Formation contour interval 50 feet*

Base map from U. S. Geological Survey topographic quadrangle: Joes Valley Reservoir, Utah, 1966

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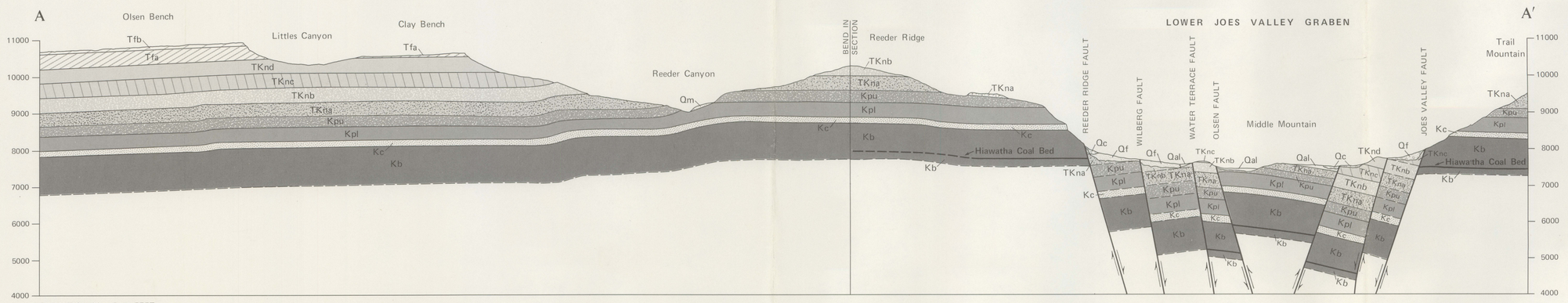
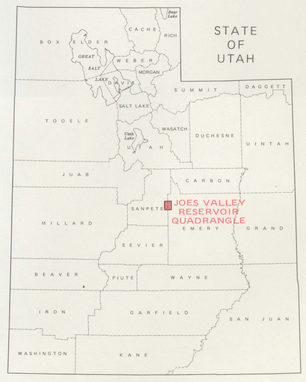
UTM GRID AND 1966 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000
1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 KILOMETER

CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 20-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL





MAP 67

PRELIMINARY GEOLOGIC MAP OF THE JOES VALLEY RESERVOIR QUADRANGLE SANPETE AND EMERY COUNTIES, UTAH

July 1982

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