Utah Geological Survey
a division of
Utah Department of Natural Resources
in cooperation with **U.S. Geological Survey**

GEOLOGIC MAP OF THE WESTWATER 30' x 60' QUADRANGLE, GRAND AND UINTAH COUNTIES, UTAH AND GARFIELD AND MESA COUNTIES, COLORADO

by

J. L. Gualtieri

Utah Geological Survey 2004
Open-File Report 441DM
digitized from U.S. Geological Survey
Miscellaneous Investigations Series Map I-1765 (1988)

WESTWATER, UTAH–COLORADO

30X60 MINUTE SERIES (TOPOGRAPHIC)

Base from U.S. Geological Survey, 1980
Projection: UTM Zone 12
Units: Meters
Datum: NAD 1927
Spheroid: Clarke 1866

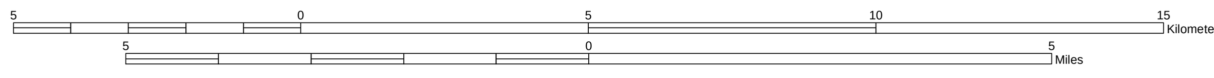
Except for changes explained in Methods section, the digital product is the same as the published map.

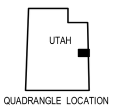
For use at 1:100,000 scale only. The Utah Geological Survey (UGS) does not guarantee accuracy or completeness of data.

The digital version of the map is a cooperative project of the UGS and the U.S. Geological Survey (USGS) funded through the STATEMAP component of the National Cooperative Geologic Mapping Program, Agreement No. 03HQAG0096.

SCALE 1:100 000

CONTOUR INTERVAL 50 METERS





QUADRANGLE LOCATION

Project Manager: Jon K. King
GIS Data Preparation: Basia Matyjasik

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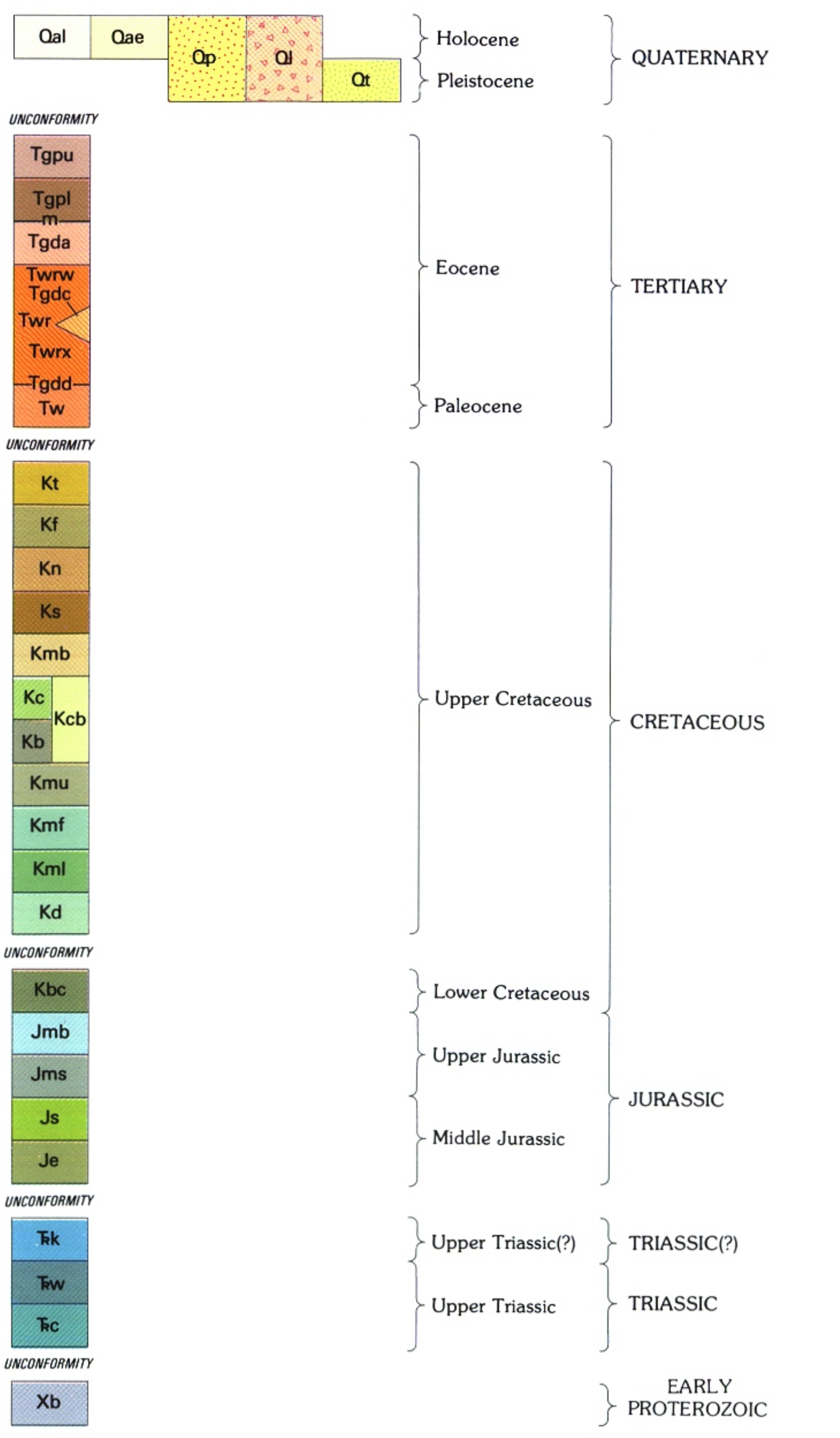
CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

Qal **Alluvium (Holocene)**—Unconsolidated clay, silt, sand, and minor gravel deposits on floors of many washes and some canyons. Includes stream-channel and flood-plain deposits, and low-level alluvial-terrace deposits as much as 10 m (33 ft) above present level of stream-channel floors

Qae **Alluvial and eolian deposits (Holocene)**—Mostly silt and sand occurring on ridges and mesa tops in southeastern part of map area

Qp **Pediment deposits (Holocene and Pleistocene)**—Unconsolidated and semi-consolidated silt, sand, and gravel veneer on pediment surfaces. Semiconsolidated conglomerate and conglomeratic sandstone occurs at base of many pediment deposits

Ql **Landslide deposits (Holocene and Pleistocene)**—Chaotically mixed masses of sandstone blocks and silty shale, mostly derived from Farrer Formation. Shown only in southwestern part of map area where conspicuously large deposits occur

Qt **Terrace gravel deposits (Pleistocene)**—Mostly boulder-size gravel deposited on terraces cut by Colorado River

Green River Formation (Eocene)

Tgpu **Parachute Creek Member, upper part**—Gray and brown, thin-bedded marlstone and siltstone; gray and brown, very fine grained to medium-grained, thin- to thick-bedded, partly cross-laminated and ripple-marked sandstone; and minor tuff and oolitic limestone. Contact with lower part of Parachute Creek Member placed at base of Horse Bench Sandstone bed about 125 m (410 ft) above Mahogany oil-shale bed. Unit incompletely preserved in map area; maximum preserved thickness about 220 m (720 ft)

Tgpl **Parachute Creek Member, lower part**—Mostly gray and brown siltstone and very fine grained sandstone, few beds of oil shale, and oolitic and algal limestone. Contact with underlying Douglas Creek Member placed at base of Mahogany oil-shale bed. Thickness approximately 140 m (450 ft) sandstone;

—m— **Mahogany oil-shale bed**—Dark-bluish-gray weathering, laminated, and commonly obscured by vegetation or soil in map area. Thickness of Mahogany oil-shale bed less than 1 m (3 ft) in map area

Douglas Creek Member

Tgda **Tongue a**—Mostly gray to brown, fine- to medium-grained sandstone, gray and green siltstone, few shale beds, and oolitic and algal limestone beds; few oil-shale beds in northern part of area. Contact with underlying Wasatch units placed at uppermost fluviatile sandstone or red shale in the Wasatch. Thickness ranges from approximately 65 to 115 m (210 to 375 ft)

Tgdc **Tongue c**—Mostly green and gray siltstone and shale, brown and gray sandstone, brown and gray algal, oolitic, and ostracodal limestone, and few thin beds of oil shale and marlstone. Contact with overlying and underlying units of Renegade Tongue of Wasatch Formation placed at beds of red shale or fluviatile sandstone in the Renegade. Thickness ranges from 0 m (0 ft) in T. 17 S., R. 22 E. to about 60 m (200 ft) in T. 16 S., R. 23 E. and about 90 m (300 ft) in T. 16 S., R. 25 E.; pinchout in subsurface trends northwestward

—Tgdd— **Tongue d**—Mostly gray shale, and oolitic and algal limestone. Contact with overlying and underlying Wasatch units placed at beds of red shale or fluviatile sandstone in the Wasatch Formation. Tongue d is approximately 1–2 m (3–7 ft) thick in southern part, as much as 15 m (50 ft) thick in western part, and as much as 30 m (100 ft) thick in eastern part of map area

Wasatch Formation (Eocene and Paleocene)

Twr **Renegade Tongue**—Brown and gray, fine- to medium-grained, thick-bedded, partly cross-bedded sandstone and shale; and red and gray siltstone and shale. Thickness of Renegade Tongue commonly about 250 m (825 ft); as much as 300 m (1,000 ft) at type locality in T. 17 S., R. 20 E. Units w and x occur east of center of T. 17 S., R. 22 E. where Douglas Creek Member and Renegade intertongue

Twrw **Unit w of Renegade Tongue**—Mostly medium to thick sandstone, indistinctly bedded, and sparse shale; includes unmapped b tongue of Douglas Creek Member of Green River Formation

Twrx **Unit x of Renegade Tongue**—Mostly red and gray shale; contains large amount of sandstone where it joins main body of Renegade Tongue

Tw **Wasatch Formation, main body**—Dark-brown conglomerate and conglomeratic sandstone containing pebbles of black chert and varicolored quartzite, commonly occurring at base of formation; very light brown and gray, fine- to medium-grained, irregularly bedded sandstone; and red and greenish-gray silty shale and siltstone, variegated in places. Contact with underlying Tuscher Formation is placed at erosional hiatus, at base of conglomeratic sequence or lowest red or greenish-gray shale. Thickness ranges from about 1,200 m (3,900 ft) in western part of map area to as little as 125 m (400 ft) in eastern part

Kt **Tuscher Formation (Upper Cretaceous)**—Mostly brown and gray, fine- to medium-grained, commonly thick-bedded sandstone, cross-bedded in most places, and olive to greenish-gray, silty shale. Uppermost sandstone locally kaolinized, and locally conglomeratic. Contact with underlying Farrer Formation placed at base of succession of thick sandstone units but indistinct in many places. Thickness ranges from approximately 100 m (325 ft) to 200 m (650 ft). Mapped to 109° W. meridian, about 4 km (2.5 mi) east of Utah-Colorado boundary; equivalent unit in Colorado is Hunter Canyon Formation

Kf **Farrer Formation (Upper Cretaceous)**—Mostly gray to brown, medium-grained, thin- to thick-bedded, commonly cross-bedded sandstone; greenish-gray, silty shale; and locally, sparse carbonaceous shale beds in lower part. Contact with underlying Neslen Formation gradational, placed where dominantly greenish-gray beds in Farrer grade downward to dominantly carbonaceous beds in Neslen. Thickness ranges from about 125 m (400 ft) to about 250 m (820 ft). Mapped to 109° W. meridian, about 4 km (2.5 mi) east of Utah-Colorado boundary; equivalent rocks in Colorado included in upper part of Mount Garfield Formation

Kn **Neslen Formation (Upper Cretaceous)**—Light-brown to brown and light-gray, very fine to fine-grained, flat- and cross-laminated to medium-bedded sandstone; medium- to very dark gray carbonaceous shale and silty shale; and small amounts of greenish-gray shale. Sandstone and shale in about equal proportions. Unit contains four coal zones not shown on map because of map scale; contains unmapped Bluecastle Sandstone Member in uppermost part in extreme southwestern part of map area. Contact with underlying Sego Sandstone usually distinct. Thickness ranges from about 60 m (200 ft) to about 150 m (500 ft). Mapped to 109° W. meridian, about 4 km (2.5 mi) east of Utah-Colorado boundary; equivalent rocks in Colorado included in lower part of Mount Garfield Formation

Ks **Sego Sandstone (Upper Cretaceous)**—Very light gray and light-gray to light-brown, fine-grained, flat- and cross-laminated to medium-bedded, partly micaceous sandstone, and sparse medium-gray sandy and silty shale. Shale becomes proportionately more abundant west of R. 20 E. Unit contains unmapped Anchor Mine Tongue of Mancos Shale in eastern part of map area. Contact with underlying Buck Tongue of Mancos Shale gradational, placed where silty sandstone grades downward to silty shale. Thickness ranges from approximately 45 m (150 ft) to about 65 m (210 ft)

Kmb **Buck Tongue of Mancos Shale (Upper Cretaceous)**—Medium- to dark-gray shale, silty and sandy in uppermost part; contains sparse limy sandstone lenses, abundant plates of selenite, and carbonized flora. Contact with underlying Castlegate Sandstone abrupt but commonly covered, placed at top of uppermost cuesta-forming sandstone unit. Thickness ranges from approximately 110 m (360 ft) at eastern boundary of map area to approximately 30 m (100 ft) at western boundary

Kc **Castlegate Sandstone (Upper Cretaceous)**—Brown to very light gray, very fine to medium-grained, laminated to medium-bedded sandstone, and sparse gray siltstone and shale; contains lenses and pods of sandy and silty marl in eastern part of map area. Unit cross-laminated and cross-bedded in western part of map area; flat laminated and ripple marked in eastern part of map area. Where unit overlies Mancos Shale, gradational and intertonguing contact placed where sandstone grades down to sandy and silty shale; where unit overlies Blackhawk Formation generally conformable and abrupt contact placed at top of coal-bearing, carbonaceous, shale beds. Thickness ranges from approximately 40 m (130 ft) near western boundary of map area to approximately 3 m (10 ft) at eastern boundary where it is shown as a single line

Kcb **Castlegate Sandstone and Blackhawk Formation, undivided (Upper Cretaceous)**—Mapped as one unit between R. 19 E. and R. 22 E. where both units are mostly composed of sandstone of similar character and cannot be differentiated. Shown as a single line in south-central part of map

Kb **Blackhawk Formation (Upper Cretaceous)**—Brown to very light gray, fine- to medium-grained, flat- to cross-laminated, and medium- to thick-bedded sandstone, and medium-gray to very dark gray, carbonaceous siltstone and shale; contains few outcrops of coal in map area. Unit contains two unmapped informal members in map area, intergrades and intertongues with underlying Mancos Shale. Thickness is as much as 100 m (330 ft)

Mancos Shale (Upper Cretaceous)

Kmu **Upper shale member**—Medium- to dark-gray shale, unit silty and sandy in uppermost part; very few limy sandstone or marly beds and lenses in places, and abundant plates of selenite throughout. Contact with underlying Ferron Sandstone Member gradational. Thickness about 1,050 m (3,450 ft)

Kmf **Ferron Sandstone Member**—Medium-gray, very fine to fine-grained, thin-bedded sandstone and sandy and silty shale. Contact with underlying lower member of Mancos Shale gradational. Thickness about 25 m (80 ft)

Kml **Lower shale member**—Medium- to dark-gray shale, and sparse siltstone and sandstone. Member locally contains zone of *Gryphea newberryi* Stanton in basal-most part. Contact with underlying Dakota Sandstone gradational; drawn where sandstone becomes dominant over sandy shale. Thickness about 100 m (325 ft)

Kd **Dakota Sandstone (Upper Cretaceous)**—Gray and brown, fine- to coarse-grained, thin- to medium-bedded, commonly cross-bedded sandstone, locally conglomeratic in basal part; and small amounts of commonly medium-gray to very dark gray and rarely greenish-gray, carbonaceous siltstone and shale. Locally proportion of shale equal to sandstone. Unit contains commonly impure lenticular coal beds. Contact with underlying Burro Canyon Formation is an erosional hiatus and is placed at base of conglomeratic sandstone or carbonaceous shale. Thickness ranges from approximately 45 m (150 ft) to 60 m (200 ft)

Kbc **Burro Canyon Formation (Lower Cretaceous)**—Light-gray to light-brown, fine- to coarse-grained, thin- to medium-bedded, commonly cross-bedded sandstone, and pale-green or variegated green, purple, and red mudstone; locally conglomeratic in basal part. Mudstone commonly more abundant than sandstone. Contact with underlying Morrison Formation placed at base of conglomeratic sandstone or dominantly pale-green mudstone beds. Thickness ranges from about 40 m (130 ft) to about 45 m (150 ft)

Morrison Formation (Upper Jurassic)

Jmb **Brushy Basin Shale Member**—Mostly red, purple, and pale-green mudstone and siltstone; sparse, very light gray to medium-gray, fine- to coarse-grained, thin- to medium-bedded, lenticular sandstone; and very sparse chert conglomerate, conglomeratic sandstone, and limestone. Contact with underlying Salt Wash Sandstone Member commonly indistinct, placed at lowest conglomeratic unit, equivalent horizon, or where dominantly mudstone sequence grades to abundant sandstone sequence. Thickness ranges from about 75 m (250 ft) to about 120 m (400 ft)

Jms **Salt Wash Sandstone Member**—Very light gray to medium-gray and light-brown, fine- to medium-grained, laminated and thin-bedded, commonly cross-bedded sandstone; subordinate red, purple, green, and gray mudstone and silty mudstone; and very sparse limestone. Contact with underlying Summerville Formation placed at top of alternating silty shale and sandstone sequence. Thickness about 65 m (215 ft)

Js **Summerville Formation (Middle Jurassic)**—Red, gray, and green shale, silty shale, and siltstone interbedded with gray and brown, fine-grained sandstone. Abrupt contact with underlying Entrada Sandstone placed at top of conspicuous white sandstone. Thickness ranges from about 13 m (40 ft) to 20 m (65 ft)

Je **Entrada Sandstone (Middle Jurassic)**—Mostly white, light-gray, yellowish-orange, and red, medium- to coarse-grained, cross-laminated and cross-bedded sandstone in upper part; red siltstone and silty sandstone in basal part. Cross laminae and cross beds in sets as thick as 3 m (10 ft). Entrada contains three unmapped members: Moab, Slick Rock, and Dewey Bridge. Contact with underlying Kayenta Formation depositional hiatus at base of red earthy-appearing siltstone beds. Thickness about 85 m (275 ft)

Ћk **Kayenta Formation (Upper Triassic?)**—Gray, pinkish-gray, and red, fine- to coarse-grained, thin- to medium-bedded, flat- and cross-bedded, partly micaceous sandstone, and purple and red siltstone and shale. Sandstone contains limestone-pebble and shale-pellet conglomerate in places. Gradational contact with underlying Windgate Sandstone placed at base of dominantly purple beds. Thickness about 100 m (330 ft)

Ћw **Wingate Sandstone (Upper Triassic)**—Very light brown, pinkish-gray, grayish-orange, and reddish-brown, very fine to fine-grained, laminated to thin-bedded, flat- and cross-bedded sandstone; contains very sparse silty and shaly partings. Abrupt, slightly undulous contact with underlying Chinle Formation placed at base of cliff-forming sandstone. Thickness about 125 m (400 ft)

Ћc **Chinle Formation (Upper Triassic)**—Red, grayish-red, and reddish-brown shale and siltstone, some interbedded red sandstone, and sparse limestone and limestone-pebble conglomerate. Formation rests with vast erosional hiatus on planar-eroded surface of Precambrian crystalline rocks. Thickness about 30 m (100 ft)

Xb **Early Proterozoic rocks**—Gneissose and schistose rocks intruded by felsic and intermediate dikes

Contact—Approximately located

Fault—Approximately located, short dashed where inferred, dotted where concealed; bar and ball on downthrown side

Anticline—Showing crestline and direction of plunge

Syncline—Showing crestline and direction of plunge

—1000— **Structure contours**—Drawn on top of Sego Sandstone in western and northeastern parts of map area; drawn on top of Dakota Sandstone in southeastern part of map area; projected 350 m (1,148 ft) from top of Wingate Sandstone where Dakota eroded. Contour interval 50 m (164 ft)

DISCUSSION

Data for the geologic map of the Westwater 30' x 60' quadrangle were derived from published mapping, principally that of Cashion (1967; 1973). Rock unit contacts above the base of the Wasatch Formation were used as previously mapped and were cartographically modified to fit the topography of the Westwater base. Likewise, contacts of rock units below the Castlegate Sandstone or Blackhawk Formation were used as previously mapped by Cashion (1973), but were slightly modified in the narrow belt of outcrops including the Dakota Sandstone, which was mapped by M. S. Ellis and J. C. Hopeck (1983, unpub. mapping).

Mapping in the course of this project was restricted to that part of the section lying between the top of the Mancos Shale and the base of the Wasatch Formation. Revisions of geographic positions of contacts between the several map units are minor but an accurate comparison cannot be made because some mapping, as for example that of Fisher (1936), is on a planimetric base.

The purpose of mapping undertaken in this project was to map the Sego Sandstone and the coal zones in the overlying Neslen Formation, which are shown on other larger-scale maps; the top of the Sego Sandstone is the datum used to correlate the coal zones.

Structure contours were drawn on the top of the Sego and Dakota Sandstones. The Sego was chosen as a structural datum because of its stratigraphic proximity to the overlying coal zones in the Neslen Formation and because its top could be mapped in outcrop and recognized in geophysical logs. Sego structure contours in the subsurface were drawn from data obtained from about 70 petroleum, natural-gas, and coal drill holes located in a belt extending from the southwestern part of the map area to the north-central and northeastern parts. No subsurface data were available in the northwestern part; in that area, the location of the contours is inferred from data extrapolated from outcrops along the canyon of the Green River and from geophysical logs of holes drilled north of the northwestern part of the map area.

Structure contours were drawn on top of the Dakota Sandstone because that formation forms conspicuous outcrops and its top can be recognized in geophysical logs. Dakota structure contours in the subsurface were drawn from the data obtained from about 125 petroleum and natural-gas drill holes located in and just outside the map area. Where the Dakota is eroded, contours are extrapolated by projecting them 350 m (1,148 ft) above the top of the Wingate Sandstone.

Many folds occur in the eastern two-thirds of the map area, roughly delineated by the boundary between R. 19 E. and R. 20 E. They lie on the northwestward-plunging nose of the Uncompahgre Plateau. The folds are clearly evident in the rocks forming the Book Cliffs and are the cause of the sinuous trace of the cliff-forming outcrops seen on the Westwater 30' x 60' quadrangle map. Extension of these structures and the presence of other structures in the subsurface are based on geophysical data obtained from petroleum and natural-gas drill holes. In the Cisco Dome and Westwater and San Arroyo anticlines, rocks as young as the Wasatch and Green River Formations are folded. In some folds, structure determined on the top of the Sego Sandstone at depth as related to the structure in surface exposures, is incongruous. This may have resulted from the misinterpretation of the structure, the miscompilation of surface rocks, or a combination of both. However, it has been demonstrated by Holmes (1979) that some of the structural incongruity in the Uinta Basin is real; structure contours drawn on the tops of the Wasatch and Green River Formations diverge because of variations in thickness of the Green River Formation.

Faults associated with the folds in the eastern two-thirds of the map area are high-angle (from vertical to 60°) normal faults that resulted from the relaxation of tectonic stress.

The Thompson and Salt Valley anticlines and associated synclinal structures in the southwestern part of the map area lie in the region of the Paradox Basin. The structures originated as early as Late Pennsylvanian time in response to the flow of salt from the Paradox Member of the Hermosa Formation to tectonically controlled loci. Salt flow and contemporaneous formation of salt structures continued through Middle or into Early Jurassic time, when salt flow ceased. In Late Cretaceous time the region was tectonically deformed, accentuating the already-existing salt-cored structures. This is evident in the Book Cliffs, along the trace of the structural axis of the Salt Valley anticline, where deformation is recognizable in beds of the Upper Cretaceous Farrer Formation but not in the basal, lowest Paleocene beds of the Wasatch Formation.

All faults associated with the Thompson and Salt Valley anticlines are high-angle normal faults and are the result of subsidence following the exsolution of salt.

REFERENCES CITED

Cashion, W. B., 1967, Geology and fuel resources of the Green River Formation, southeastern Uinta Basin, Utah and Colorado: U.S. Geological Survey Professional Paper 548, pls. 1 and 2.

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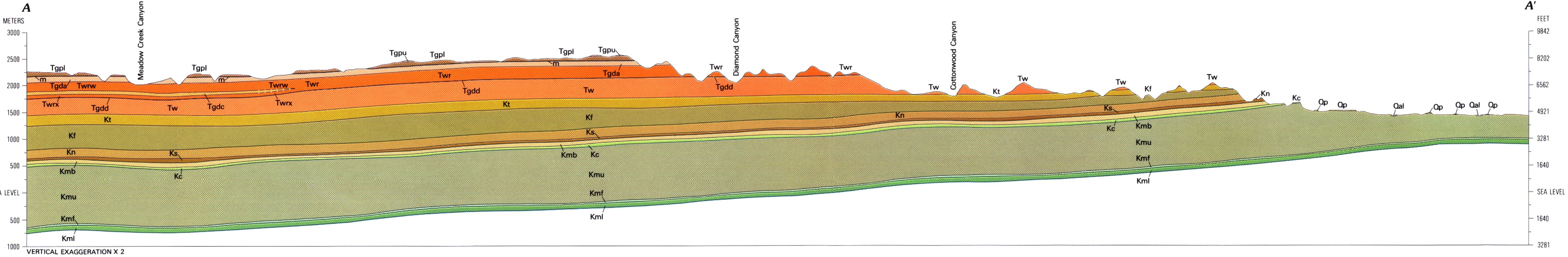

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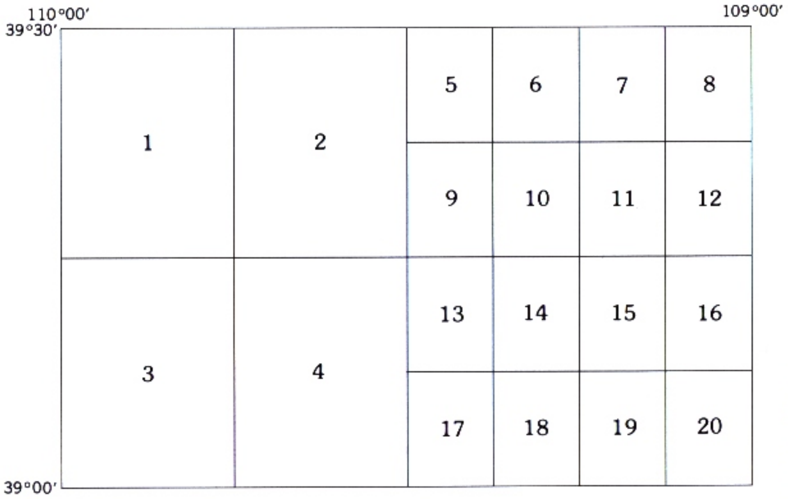

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2. Tenmile Canyon—1963
3. Floy Canyon—1963
4. Sego Canyon—1963

SCALE 1:24,000

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6. P R Spring—1970
7. San Arroyo Ridge—1970
8. Jim Canyon—1970
9. Preacher Canyon—1970
10. Dry Canyon—1970
11. Bryson Canyon—1970
12. Bar X Wash—1970
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15. Harley Dome—1970
16. Bitter Creek Well—1970
17. Cisco Springs—1970
18. Danish Flat—1970
19. Westwater 4 SW—1954
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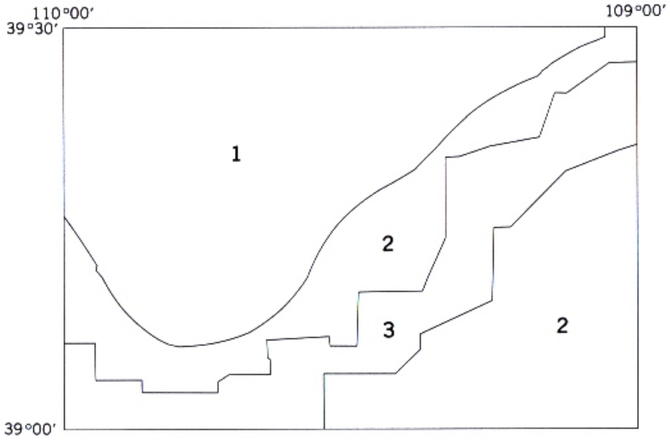

INDEX MAP SHOWING PRINCIPAL SOURCES OF GEOLOGIC DATA

1. Cashion, W. B., 1967, Geology and fuel resources of the Green River Formation, southeastern Uinta Basin, Utah and Colorado: U.S. Geological Survey, Professional Paper 548, plate 1.
2. ________ 1973, Geologic and structure map of the Grand Junction quadrangle, Colorado and Utah: U.S. Geological Survey Miscellaneous Geologic Investigations Map I–736.
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