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

GEOLOGIC MAP OF THE HUNTINGTON 30' x 60' QUADRANGLE, CARBON, EMERY, GRAND, AND UINTAH COUNTIES, UTAH

by
Irving J. Witkind

Utah Geological Survey 2004
Open-File Report 440DM
digitized from U.S. Geological Survey
Miscellaneous Investigations Series Map I-1764 (1988)

HUNTINGTON, UTAH

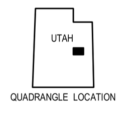
30X60 MINUTE SERIES (TOPOGRAPHIC)

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

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

5 0 5 10 15 Kilometers
5 0 5 Miles



QUADRANGLE LOCATION

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

UTAH GEOLOGICAL SURVEY 2004
Open-File Report 440DM
Geologic Map of the Huntington 30' x 60' Quadrangle, Carbon, Emery, Grand and Uintah Counties, Utah
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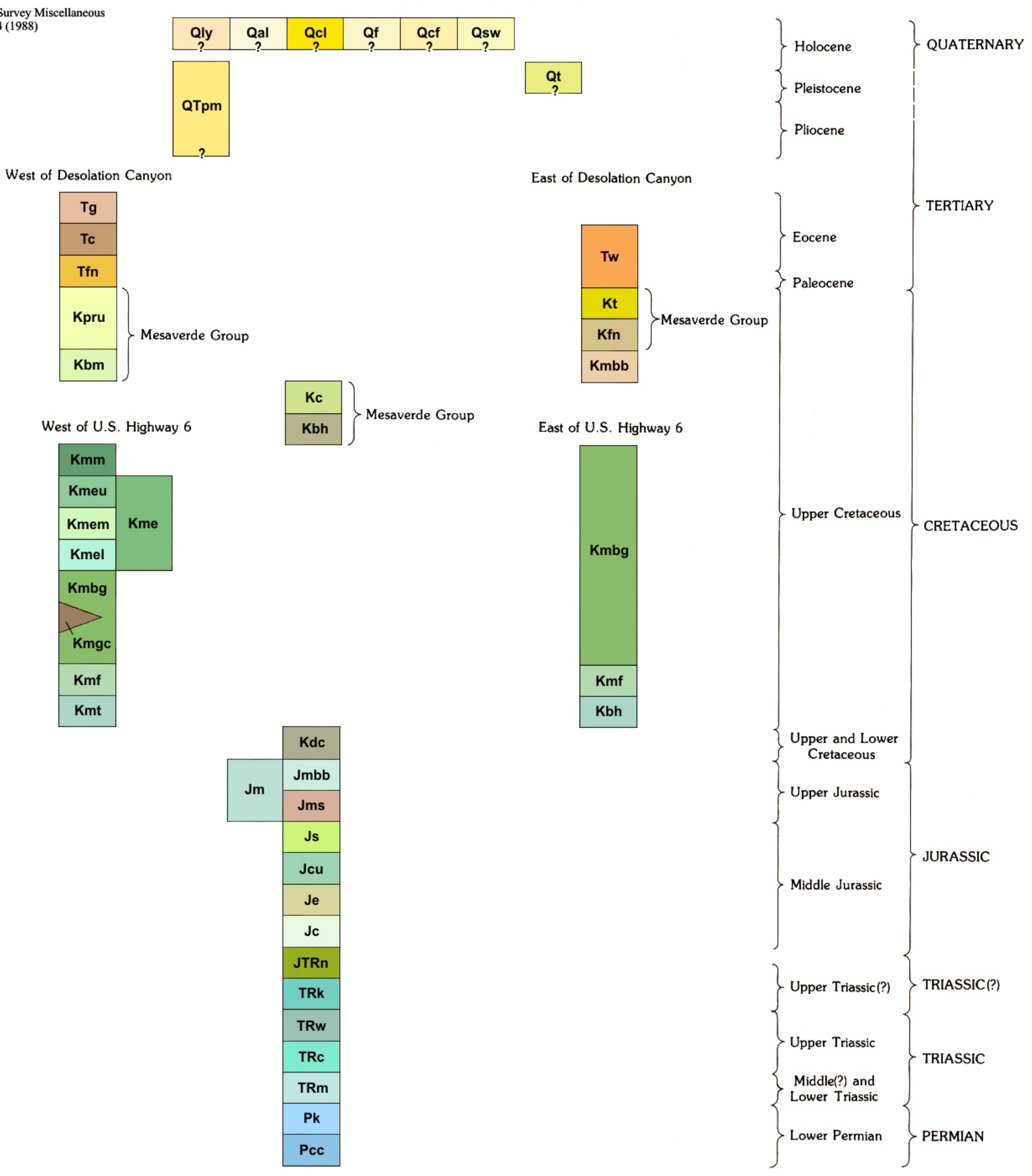
Digitized from U.S. Geological Survey Miscellaneous Investigations Series Map I-1764 (1988)

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

QUATERNARY DEPOSITS

Qal **Alluvium (Holocene)**—Dark-brown to gray, thin- to thick-bedded deposit of clay, silt, sand, granules, pebbles, and sparse cobbles. Unconsolidated. Forms broad, even surfaces of low relief. Thickness ranges widely; commonly less than 15 m (50 ft) thick

Qcl **Colluvium (Holocene)**—Brown to dark-brown heterogeneous mixture of fragments of many sizes and shapes that locally mantle lower valley walls and accumulate at base of steep cliffs. Chiefly siltstone and sandstone clasts. Unconsolidated to semiconsolidated. Thickness ranges from a few centimeters (one inch) to as much as 15 m (50 ft)

Qf **Alluvial fan deposit (Holocene)**—Light-brown to brown, unconsolidated to semiconsolidated, lobate deposit of moderately well-sorted silt, sand, granules, pebbles, and cobbles at stream mouths. Chiefly siltstone and sandstone clasts. Thickness uncertain, probably as much as 15 m (50 ft) locally

Qcf **Coalesced alluvial fan deposit (Holocene)**—Brown to dark-brown, thin- to thick-bedded, unconsolidated to semiconsolidated deposits of silt, sand, granules, pebbles, cobbles, and sparse boulders. Crossbedded. Clasts, chiefly siltstone, sandstone, and limestone, reflect formations exposed in drainage area. Formed as a result of overlap and interfingering of adjacent alluvial fans; forms broad, low, sloping aprons at foot of adjacent highlands. Thickness uncertain; possibly as much as 30 m (100 ft) locally

Qsw **Slope wash (Holocene)**—Light- to dark-gray, thin- to thick-bedded deposit of clay, silt, sand, granules, and some pebbles. Faintly crossbedded. Unconsolidated to weakly cemented. Clasts, chiefly siltstone and sandstone, reflect formations exposed in adjacent upland. Forms broad, gently sloping sheets. Thickness ranges from a thin film to as much as 8 m (25 ft)

QTpm **Pediment mantle (Holocene to Pliocene)**—Light-brown to brown, gray, and locally reddish-brown deposit of silt, sand, granules, pebbles, cobbles, and boulders derived from adjacent uplands. Massive to crudely bedded. Unconsolidated to well cemented. Chiefly siltstone and sandstone clasts. Surfaces are even and slope gently away from uplands. Ranges in thickness from about 3 m (10 ft) to more than 45 m (150 ft)

Qt **Terrace deposit (Quaternary)**—Light- to dark-brown, thin- to medium-bedded deposit of silt, sand, granules, pebbles, cobbles and a few boulders. Crossbedded. Clasts, chiefly siltstone, sandstone, and limestone, reflect formations exposed in adjacent uplands. Forms narrow, sloping benches adjacent to and above major rivers and tributaries. Thickness ranges from about 3 m (10 ft) to about 6 m (20 ft)

Qly **Young lacustrine deposits (Quaternary)**—Playa deposits around Buckhorn Reservoir. Not field checked.

TERTIARY SEDIMENTARY ROCKS

Tg **Green River Formation (Eocene)**—Light-gray, gray, and yellowish-brown calcareous mudstone, shale, and sandstone. Thin bedded; finely laminated. Forms rounded noses and broad even uplands. Fresh-water lacustrine deposit. Only basal 75 m (250 ft) of formation represented in this quadrangle

Tc **Colton Formation (Eocene)**—Yellowish- to grayish-brown, thin-bedded, fine- to medium-grained quartzose sandstone interlayered with irregular and discontinuous beds of dark-reddish-brown mudstone and shaly siltstone. Locally variegated in shades of red and gray. Forms steep, steplike slopes. Fluvial deposit. About 460 m (1,500 ft) thick

Tw **Wasatch Formation (Eocene and Paleocene)**—Variegated mudstone in shades of red, green, and gray intercalated with beds and lenses of sandstone, conglomerate, and minor carbonate. West of Desolation Canyon of Green River (along east edge of map), Colton is separable from underlying similar-appearing North Horn Formation by interleaved limestone beds of Flagstaff Member of Green River Formation. These limestone beds persist east of Desolation Canyon, but they become thinner and fewer in number, and where they are sparse, Colton is separable from North Horn only with great difficulty. To resolve this cartographic problem I have arbitrarily grouped beds west of Desolation Canyon (a readily recognizable geographic feature) into two stratigraphic units: "Flagstaff Member of Green River Formation and North Horn Formation, undivided" (Tfn), and "Colton Formation" (Tc). East of Desolation Canyon I have grouped North Horn, Flagstaff, and Colton into "Wasatch Formation" (Tw), following usage suggested by Fouch (1976)

TERTIARY AND CRETACEOUS SEDIMENTARY ROCKS

Tfn **Flagstaff Member of Green River Formation (Paleocene) and North Horn Formation (Paleocene)**—Interbedded deposits of reddish-brown and grayish-brown mudstone with lesser amounts of siltstone, sandstone, limestone conglomerate, and limestone; some carbonaceous shale. Medium to thick bedded. Appears as an irregular alternation of resistant and nonresistant beds. Siltstones are calcareous. Sandstones are quartzose, fine grained, locally coarse grained. Interbedded fresh-water limestones are light gray to gray, dense, thin bedded, and locally contain fossil hash. Lacustrine and fluviatile deposit. About 490 m (1,600 ft) thick. The Tertiary-Cretaceous boundary in the western Book Cliffs is within the sequence of beds described above. W. B. Cashion and T. D. Fouch (U.S. Geological Survey, oral commun., 1981) have suggested that a distinctive, well-developed, easily recognizable white zone of kaolinite-rich sandstone beds marks the Cretaceous-Tertiary boundary. The zone, commonly referred to as a "bleached zone," is readily traceable across much of the area. It appears to be the same zone as that recognized in the Piceance Creek Basin in Colorado by Johnson and May (1980), who refer to it as the "white-colored kaolinitic zone." I have arbitrarily assigned units above the bleached zone to the undivided Flagstaff Member of the Green River Formation and North Horn Formation (Tfn) and have included the zone with the upper part of the Price River Formation (Kpru). In the past the significance of the bleached zone was not recognized, and all strata between the top of the Bluecastle Sandstone Member (of the Price River Formation) and the base of the Colton Formation, in the map area, were combined and mapped as the "Flagstaff Limestone (Eocene(?) and Paleocene) and North Horn Formation (Paleocene and Upper Cretaceous)" (Osterwald and Maberry, 1974). In those localities where the bleached zone cannot be found, either because it is missing or because I have been unable to locate it, I have followed the mapping of Osterwald and Maberry (1974)

CRETACEOUS SEDIMENTARY ROCKS

Price River Formation and Castlegate Sandstone (Upper Cretaceous)—Throughout much of the Wasatch Plateau, the Price River Formation is divisible into an upper part of the Price River Formation (Kpru) and the Bluecastle Sandstone Member and mudstone member(Kbm), both of which are underlain by the Castlegate Sandstone (Kc). The upper part of Price River Formation consists of a series of conglomerates, conglomeratic sandstones, and sandstones. These units are equivalent to part of undivided Tuscher and Farrer Formations of eastern Book Cliffs (Fouch and others, 1983, fig. 3). East of Desolation Canyon of the Green River, and to some extent directly west of the canyon, the gross lithologies of the Tuscher, Farrer, and Neslen Formations are distinctive and readily recognizable units. As one proceeds westward, however, the distinction between these formations lessens, and they are separable only with great difficulty. For cartographic purposes, therefore, I have selected Desolation Canyon as an arbitrary, easily recognized geographic boundary. East of the the canyon I have mapped as two discrete units the Tuscher Formation and the Farrer and Neslen Formations (undivided); west of the canyon I have mapped equivalents of the formations as the upper part of the Price River Formation. East of Desolation Canyon I have used the top of the "bleached zone" as the boundary between the Cretaceous Tuscher Formation and the overlying undivided Flagstaff Member of the Green River Formation and North Horn Formation

East of Desolation Canyon

Kt **Tuscher Formation (Upper Cretaceous)**—Light-gray to gray, thick-bedded to massive, interbedded quartzose sandstone and mudstone. Forms high cliffs and steep slopes. Fluvial deposit. Thickness about 40 m (130 ft)

Kfn **Farrer and Neslen Formations (Upper Cretaceous)**—Gray, greenish-gray, and yellowish-brown, medium- to thick-bedded alternating sequence of crossbedded quartzose sandstone and mudstone; locally lower part contains coal beds. Commonly forms ledges and gentle slopes. Locally includes Sego Sandstone in southeast section of quadrangle. Fluvial, floodplain, and swamp deposits. About 185 m (600 ft) thick

Kmbb **Buck Tongue of Mancos Shale (Upper Cretaceous)**—Gray to dark-gray shale interbedded with lenses of brown to grayish-brown quartzose sandstone. Marine deposit. About 150 m (500 ft) thick

West of Desolation Canyon

Kpru **Upper part of Price River Formation (Upper Cretaceous)**—Reddish-brown, grayish-brown, gray, and yellowish-brown, medium to thick beds of sandstone and mudstone that alternate irregularly to form steep, steplike slopes. Units are very much like those in lower part of overlying undivided Flagstaff Member of Green River Formation and North Horn Formation (Tfn). Fluvial deposit. Thickness about 75 m (250 ft)

Kbm **Bluecastle Sandstone Member and mudstone member of Price River Formation (Upper Cretaceous)**—Fouch and others (1983) show this as part of Castlegate sandstone.

Bluecastle Sandstone Member—Light-gray, gray, and yellowish-brown, medium- to thick-bedded, fine- to medium-grained quartzose sandstone. Forms cliffs and ledges. Fluvial deposit. Thickness ranges from 15 to 75 m (50 to 250 ft)

Mudstone member—Gray to dark-gray and grayish-brown, thin- to medium-bedded mudstone interleaved with siltstone and sandstone. Forms gentle slopes. Fluvial and floodplain deposits. Thickness ranges from 30 to 120 m (100 to 400 ft)

Kc **Castlegate Sandstone (Upper Cretaceous)**—Light-gray to dark-gray, locally yellowish-brown to dark-brown, thick-bedded to massive, fine- to coarse-grained quartzose sandstone. Commonly forms cliffs or steep slopes. Fluvial deposit. About 40 m (130 ft) thick

Kbh **Blackhawk Formation and Star Point Sandstone (Upper Cretaceous)**—Dominantly light-gray, light-brown, and brownish-gray, thin- to medium-bedded, crossbedded, fine- to medium-grained quartzose sandstone interleaved with shaly siltstone, shale, carbonaceous shale, and coal. Many thin to thick coal zones in lower part; major thick coal zone at base directly overlies light-brown, fine- to medium-grained, quartzose Star Point Sandstone (a gradational unit between underlying Mancos Shale and Blackhawk Formation). In map area Blackhawk Formation contains two or three coal seams, a result of the splitting of the Upper Sunnyside coal bed. Deltaic and interdeltaic deposits. Ranges in thickness from about 215 m (700 ft) to about 305 m (1,000 ft)

West of U.S. Highway 6

Mancos Shale (Upper Cretaceous)—Consists of six members (in descending order): upper part of the Blue Gate, Emery Sandstone, Blue Gate, Garley Canyon Sandstone, Ferron Sandstone, and Tununk. Marine deposit. Total thickness ranges from 700 m (2,300 ft) to 1,860 m (6,100 ft)

Kmu **Upper part of Mancos Shale**

Kmm **"Masuk Member"** — Light-gray, bluish-gray, and dark-gray, thin- to medium-bedded shale and shaly siltstone; few thin interlayered brown sandstone beds. Includes sparse discontinuous ledges of silicified shale. About 305 m (1,000 ft) thick. In the past this unit has been called "Masuk Member" of the Mancos Shale. Peterson and Ryder (1975), however, suggest that this unit is neither of same age nor lithology as Masuk of Henry Mountains area. They propose, therefore, that the name Masuk be restricted to strata in the Henry Mountains area and that units in this area previously known as Masuk be referred to as "upper part of Blue Gate Member." Fouch and others (1983, Appendix C) concur with this recommendation

Kme **Emery Sandstone Member—Consists of upper and lower sandstone units separated by a middle shale unit. Shown undivided only on cross section. Total thickness of member about 90 m (285 ft).** Not present east of Highway 6

Kmeu **Upper sandstone unit**—Light-brown, yellowish-brown, and grayish-brown, thin- to medium-bedded, locally crossbedded, very fine grained to fine-grained quartzose sandstone. Weathers to thin angular plates. Stands as low cliffs. About 11 m (35 ft) thick

Kmem **Middle shale unit**—Light-gray to gray, thin- and even-bedded shale and shaly siltstone. Sandy locally. Few thin interleaved sandstone beds that weather as steplike prominences. About 60 m (200 ft) thick

Kmel **Lower sandstone unit**—Light-brown, yellowish-brown, and grayish-brown, thin- to medium-bedded, very fine grained to fine-grained quartzose sandstone. Stands as a low cliff. About 15 m (50 ft) thick

Kmbg **Blue Gate Member**—Light-gray, bluish-gray, and gray, thin- to medium-bedded shale and shaly siltstone. Sparse interlayered thin sandstone beds. Forms low rounded hills. Resembles upper part of Blue Gate and Tununk Members. As much as 610 m (2,000 ft) thick

Kmgc **Garley Canyon Sandstone Member**—Consists of two thin sandstone beds separated by dark-gray shale. Sandstone is light gray to light brown, locally orangish brown, thin and even bedded, very fine to fine grained, and quartzose. Locally crossbedded. Salt and pepper aspect. Firmly cemented by calcium carbonate. Stands as low cliffs. Member ranges in thickness from a pinch-out to about 8 m (0 to 25 ft)

Kmf **Ferron Sandstone Member**—Consists of upper and lower sandstone units separated by a middle shale unit. Member is about 50 m (160 ft) thick

Upper and lower sandstone units—Light-brown, thin- and even-bedded, crossbedded, very fine to fine-grained sandstone. Contains many large rounded concretions. Each sandstone bed stands as a cliff or a prominent series of ledges

Middle shale unit—Light-gray to dark-gray, thin- to medium-bedded, even-bedded shale and shaly siltstone

Kmt **Tununk Member**—Light-gray to dark-gray, thin- to medium-bedded, even-bedded shale and shaly siltstone. Locally contains discontinuous ledges of silicified shale. Few sandstone concretions. Forms low rounded hills. Ranges in thickness from 120 to 200 m (400 to 650 ft)

East of U.S. Highway 6

Kmbg **Blue Gate Member of Mancos Shale** —Light-gray, bluish-gray, and dark-gray, thin- to medium-bedded shale and shaly siltstone. Few thin interlayered brown sandstone beds. Includes sparse discontinuous ledges of silicified shale. About 1,070 m (3,500 ft) thick

Kmf **Ferron Sandstone Member**—Similar to exposures west of U.S. Highway 6

Kmt **Tununk Member**—Similar to exposures west of U.S. Highway 6

Units exposed throughout Huntington quadrangle

Kdc **Dakota Sandstone and Cedar Mountain Formation**

Dakota Sandstone (Upper Cretaceous)—Tan to light-brown, thin-bedded, crossbedded, fine- to medium-grained quartzose sandstone. Contains thin discontinuous carbonaceous seams. Beach to marginal-marine deposit; deltaic. Thickness ranges from a pinch-out to 9 m (0 to 30 ft)

Cedar Mountain Formation (Lower Cretaceous)—Consists of two units. Total thickness ranges from 50 to 70 m (160 to 230 ft)

Upper unit—Dominantly massive to thick-bedded mudstone variegated in shades of purple, red, gray, and green; few discontinuous sandstone lenses; thickness ranges from 45 to 75 m (150 to 250 ft)

Lower unit—Gray, massive to thick-bedded, crossbedded conglomerate and conglomeratic sandstone; consists of well-rounded clasts of white quartz, black, brown, and light-gray chert, and white quartzite; forms resistant ledge. Fluvial deposit. Thickness ranges from 3 to 25 m (10 to 80 ft)

JURASSIC SEDIMENTARY ROCKS

Jm **Morrison Formation (Upper Jurassic)**—Consists of Brushy Basin Member(Jmbb) underlain by the Salt Wash Sandstone Member (Jms). Fluvial deposit. Shown undivided only on cross section. Total thickness ranges from 105 to 120 m (350 to 400 ft)

Jmbb **Brushy Basin Member**—Variegated, dominantly bluish-gray and gray with bands of yellow, green, maroon, brick-red, and purple claystone and mudstone. Bentonitic. Contains few thin limestone and sandstone beds. Limestone beds locally gray and nodular. Ranges in thickness from 45 to 75 m (150 to 250 ft)

Jms **Salt Wash Sandstone Member**—Light-gray, thin- to medium-bedded, crossbedded, fine- to coarse-grained, friable quartzose sandstone, and lenticular beds of conglomeratic sandstone and conglomerate. Some interbedded gray and purple mudstone. Stands as low cliff or rounded ledges. About 55 m (180 ft)

Js **Summerville Formation (Middle Jurassic)**—Reddish-brown, shaly siltstone and sandstone; thin, even, and continuous bedding is characteristic. Many interlayered seams and thin beds of gypsum. Stands as low cliffs. Tidal-flat deposit. Ranges in thickness from about 35 to 75 m (120 to 250 ft)

Jcu **Curtis Formation (Middle Jurassic)**—Light-gray, light-brown, greenish-gray, thin- to medium-bedded, locally crossbedded, fine- to medium-grained quartzose sandstone. Minor beds of siltstone, conglomeratic sandstone, and conglomerate. Glauconitic. Breaks into angular platy fragments. Firmly cemented by calcium carbonate; forms ledges that act as resistant caps. Some interbedded red and gray shale. Marine deposit. Ranges in thickness from about 20 to 75 m (75 to 250 ft)

Je **Entrada Sandstone (Middle Jurassic)**—Orangish-brown, reddish-brown, and locally light-brown sandstone; medium to thick bedded; dominantly fine grained, locally medium to coarse grained; faintly crossbedded; friable. Few thin interlayered lenses of shaly siltstone and mudstone; earthy. Forms rounded ledges, horizontally grooved low cliffs, and steep slopes. Nearshore eolian deposit. Ranges in thickness from 60 to 95 m (200 to 300 ft)

Jc **Carmel Formation (Middle Jurassic)**—Consists of two units: an upper reddish-brown shaly siltstone and a lower unit of light-gray, fossil-rich crystalline limestone. Marine deposit. Total thickness ranges from 85 to 105 m (280 to 350 ft)

Upper unit—Reddish-brown, thin-bedded shaly siltstone. Few thin sandstone beds in upper part. Contains many small (0.5 to 2 m (2 to 5 ft) thick) intercalated lenses and beds of gypsum that are much contorted in places and that locally coalesce to form beds about 8 m (25 ft) thick. Forms broad, intricately dissected slopes. About 75 m (250 ft) thick

Lower unit—Light-gray to brownish-gray, locally pale-green, thin-bedded, dense limestone. In places passes laterally into a very fine-grained calcareous sandstone. Marked by ripple marks, raindrop pits and other evidence of shallow-water deposition. Fossiliferous. Locally underlain by a thin bed (about 5 m (15 ft) thick) of reddish-brown to yellowish-green shaly siltstone. Ranges in thickness from 9 to 15 m (30 to 50 ft)

JURASSIC AND TRIASSIC(?) SEDIMENTARY ROCKS

JTRn **Navajo Sandstone (Jurassic and Upper Triassic?)**—Light-brown to light-gray, thick-bedded to massive, fine-grained quartzose sandstone; crossbedded in large trough sets; clean and friable. Contains a few thin (about 2 m (5 ft) thick), lenticular, light-gray limestone beds in upper part. Stands as steep cliffs and rounded knolls. Eolian deposit. Ranges in thickness from 120 to 305 m (400 to 1,000 ft)

TRIASSIC SEDIMENTARY ROCKS

TRk **Kayenta Formation (Upper Triassic?)**—Lavender, reddish-brown, and pale-red, thin- to medium-bedded, irregularly bedded and crossbedded, fine- to coarse-grained sandstone. Some shaly siltstone. Well cemented by calcium carbonate. Locally contains a few conglomerate lenses rich in shaly siltstone clasts. Forms benches and steep slopes between cliffs developed on overlying Navajo and underlying Wingate Sandstones. Grades into both overlying and underlying units. Fluvial deposit. Ranges in thickness from 30 to 75 m (100 to 250 ft)

TRw **Wingate Sandstone (Upper Triassic)**—Reddish-brown to brown, thick-bedded to massive, crossbedded, fine-grained quartzose sandstone. Well cemented by calcium carbonate. Stands as vertical cliffs that form an impassable barrier. Strongly stained with manganese oxide (desert varnish). Eolian deposit. Ranges in thickness from 105 to 135 m (350 to 450 ft),

TRc **Chinle Formation (Upper Triassic)**—Divisible into three members, in descending order

Church Rock Member—Reddish-brown to dark-brown, locally light-gray and greenish-gray, thin- to medium-bedded sandstone and shaly siltstone. Lenticular. Contains many ripple marks and mud cracks. Fluvial deposit. Ranges in thickness from 45 to 55 m (150 to 175 ft)

Moss Back Member—Consists of light-gray to gray, thin- to medium-bedded crossbedded sandstone, conglomeratic sandstone, and sparse conglomerate. Minor interbedded mudstone. Lenticularity and extreme variability in bedding are common. Chiefly granules and pebbles of quartz, quartzite, and chert in a well-cemented matrix of medium to coarse sand. Much fossil wood. Cliff and bench former. Fluvial deposit. In the past, these units have been mapped as the Shinarump Conglomerate (Gilluly, 1929, pl. 30)

Temple Mountain Member—In places, lowermost beds of Chinle are altered and marked by purple and white mottles. This purple-white zone, described and named by Finch (1953), locally extends below basal part of the Chinle into uppermost beds of underlying Moenkopi Formation. Combined thickness of Moss Back and Temple Mountain Members ranges from 20 to 55 m (70 to 175 ft)

TRm **Moenkopi Formation (Middle(?) and Lower Triassic)**—Marine deposit. Consists of three parts which together range in thickness from 115 to 285 m (375 to 935 ft). Elsewhere on the Colorado Plateau the Moenkopi Formation commonly is a deep reddish brown. In this sector of the San Rafael Swell, however, the reddish-brown color has been bleached to a pale greenish gray, which weathers to a yellowish brown. These altered rocks trend northwestward to form a belt, about 13 km (8 mi) wide, that is nearly coextensive with the older northwest-trending anticline concealed beneath the San Rafael anticline (Hawley and others, 1968, p. 40-41). Johnson (1957, p. 45) has suggested that the bleaching of the rocks results from the reducing effects of petroleum or associated natural gas when they migrated into this older anticline

Upper part—Altered greenish-gray, locally reddish-brown, thin- to medium-bedded, very fine grained sandstone and shaly siltstone. Platy; ripple marked petroliferous. Slope former. In places, uppermost units are marked by purple and white mottles, the purple-white zone of Finch (1953); these mottles have also been found in lower part of Chinle Formation. Ranges in thickness from 60 to 185 m (200 to 600 ft)

Sinbad Limestone Member—Yellowish-gray to light-brown, thin- to medium-bedded, crystalline, locally oolitic limestone. Contains few thin shaly siltstone and very fine grained sandstone beds. Forms resistant cap and long dip slopes. Ranges in thickness from 12 to 45 m (40 to 150 ft)

Lower part—Greenish-gray to yellowish-brown, thin- to medium-bedded, quartzose sandstone, shaly siltstone, and interbedded mudstone. Light-gray, thin-bedded limestone at base. Forms gentle slopes. Ranges in thickness from 45 to 60 m (150 to 200 ft)

PERMIAN SEDIMENTARY ROCKS

Pk **Kaibab Limestone (Lower Permian)**—Light-brown to brown, thin- to medium-bedded, even-bedded limestone. Locally sandy. Light-brown, thin, calcareous sandstone at base that reflects reworking of underlying Cedar Mesa Sandstone of Cutler Formation (called Coconino Sandstone by some). Resistant, forms dip slopes. Contains chert geodes; fossiliferous. Marine deposit. Ranges in thickness from 12 to 25 m (40 to 80 ft)

TRc **Cedar Mesa Sandstone Member of the Cutler Formation (Lower Permian)**—Light-brown to light-gray, thick-bedded to massive, strongly crossbedded, medium- to coarse-grained, friable quartzose sandstone. Firmly cemented by calcium carbonate. Stands as steep slopes and cliffs. Eolian deposit. Base not exposed, but probably about 185 m (600 ft) thick. In the past this sandstone has been mapped as Coconino Sandstone. Some uncertainty exists as to whether this sandstone is truly correlative with type Coconino in the Grand Canyon region. McKee (1954, p. 23) has noted a progressive northward thinning of type Coconino from the Grand Canyon area, and he thinks it may pinch-out north of Utah-Arizona border. Baars (1962) states that Coconino Sandstone is almost entirely confined to northern Arizona. And Welsh and others (1979) have stated that unit called Coconino in the San Rafael Swell is Cedar Mesa Sandstone of Cutler Formation

Contact

Gradational contact — In NW corner of map area between QTpm - Qsw and along Green River between Qal - Qf

Fault—Dashed where approximately located; dotted where concealed; queried where uncertain. Bar and ball on downthrown side

Linear feature

Collapse feature

Inactive uranium mine

Anticline—Approximately located. Showing crestline and dip of limbs. Dotted where concealed

Syncline—Approximately located. Showing crestline and dip of limbs

Strike and dip of beds

Horizontal beds

Changes by Utah Geological Survey

The Utah Geological Survey made minor corrections and clarifications using the source maps listed on U.S. Geological Survey Map I-1764 (source for map on this disc) and Witkind and McGimsey (1979).
The UGS also made changes to unit labels and unit descriptions using Fouch and others (1983) and U.S. Geological Survey (2003), which post-dates the map, but clarifies the upper Cretaceous stratigraphy and unit thicknesses.
Major changes include:
Relabeling unit Kmu on map as Kmbg (Blue Gate Member of Mancos Shale) and noting pinch out of the Blue Gate Member in unit description on this disc; the Emery Sandstone is not present east of the San Rafael Swell (east of U.S. Highway 6).
Kmu unit label is only used on the map on this disc near Huntington anticline where geology on map is not consistent with stratigraphy shown on map or geology shown on adjacent U.S. Geological Survey map (Witkind and others, 1987).
Relabeling map unit Kmub (upper part of Blue Gate Member) as Kmm on disc map to show that it is the tongue above the Emery Sandstone that was formerly called the Masuk Tongue of Mancos Shale on adjacent map (Witkind and others, 1987). The proper name of this tongue is beyond the scope of this project.
Noting in Kbm map unit description on this disc that the Bluecastle Sandstone Member is actually a tongue of the Castlegate Sandstone and the mudstone member below it is likely a tongue of the Neslen Formation.

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UTAH GEOLOGICAL SURVEY 2004
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Geologic Map of the Huntington 30' x 60' Quadrangle,
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By Irving J. Witkind
Digitized from U.S. Geological Survey Miscellaneous
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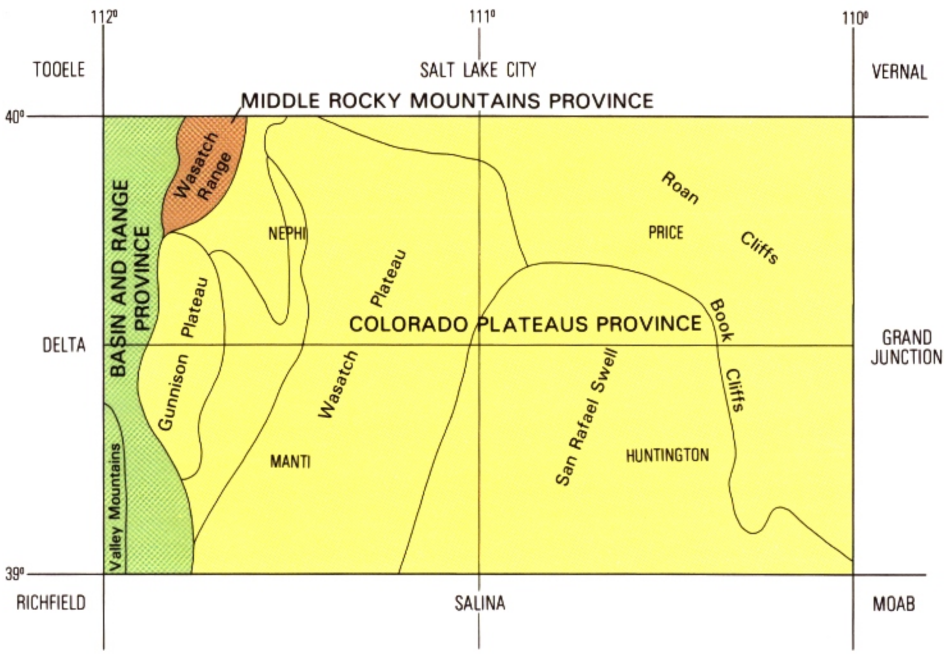
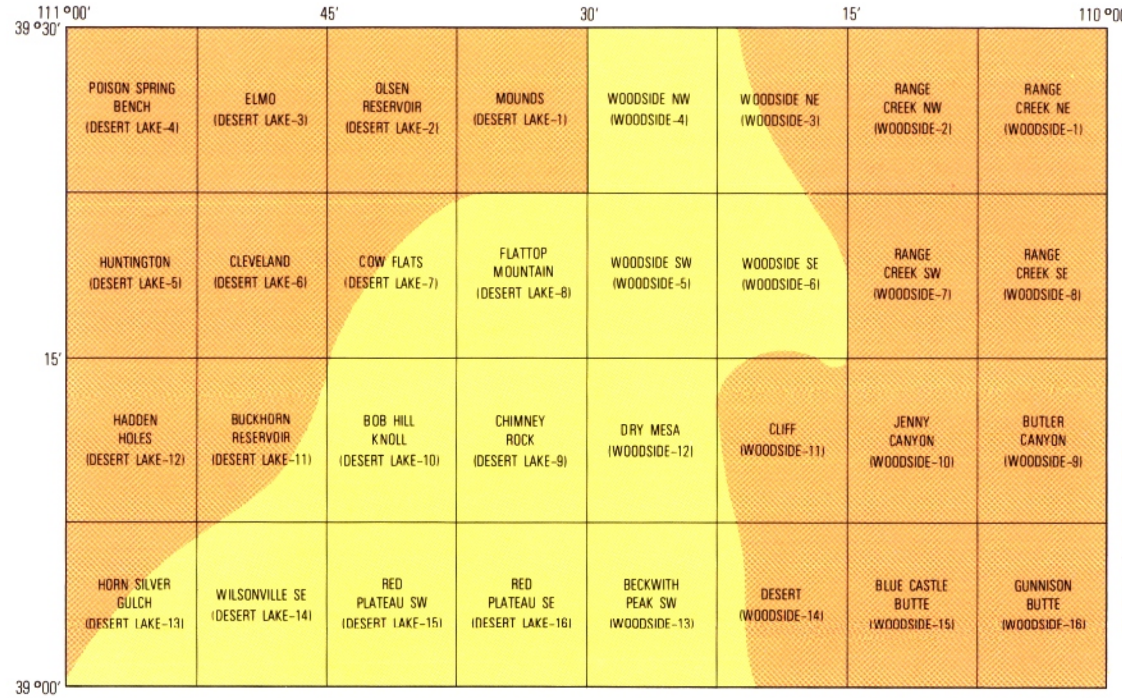


Figure 1.—Sketch map showing regional physiographic features of the Price 1° × 2° quadrangle.



EXPLANATION

Original data unmodified or slightly modified

Original data modified by I. J. Witkind

NOTE: Much of the existing geologic data were available only on planimetric base maps. Consequently all data were transferred, chiefly in the field, to modern 1:24,000-scale topographic maps (1953–1976) which were then reduced photographically to 1:100,000 scale. The geologic data on these reduced maps were then drafted onto the 1:100,000-scale topographic map of the Huntington 30' × 60' quadrangle (1980). Former names of quadrangles are in parentheses.

INDEX OF 7.5-MINUTE (1:24,000-SCALE) QUADRANGLES USED IN COMPILATION

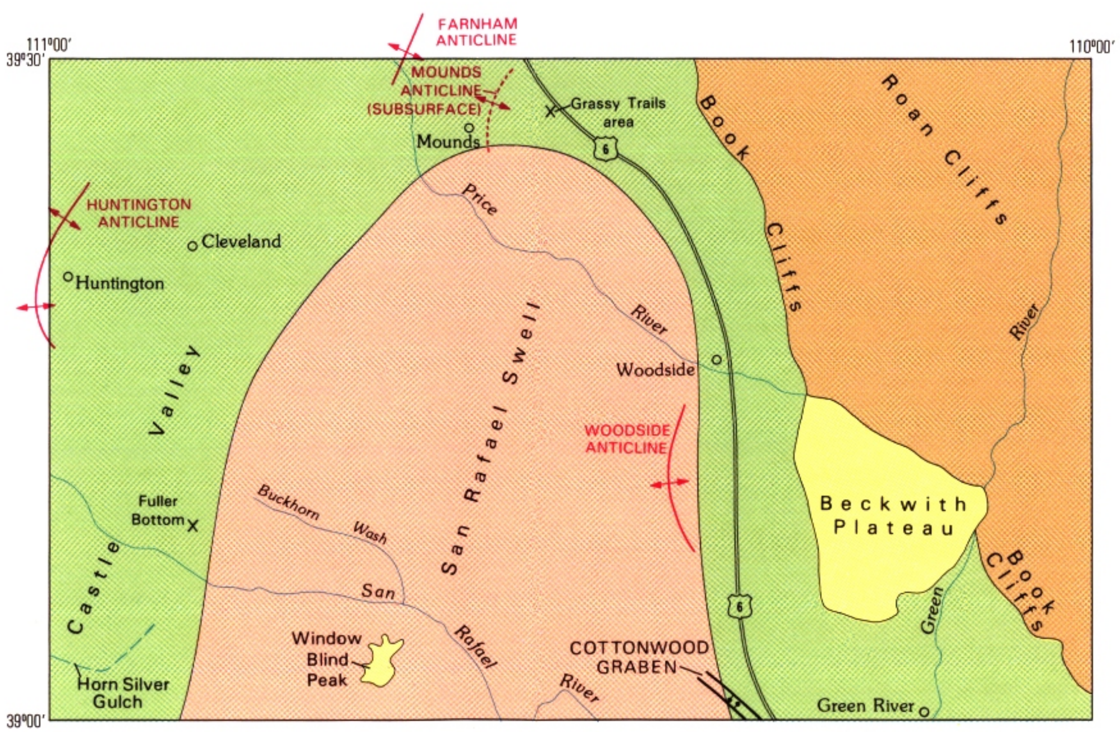
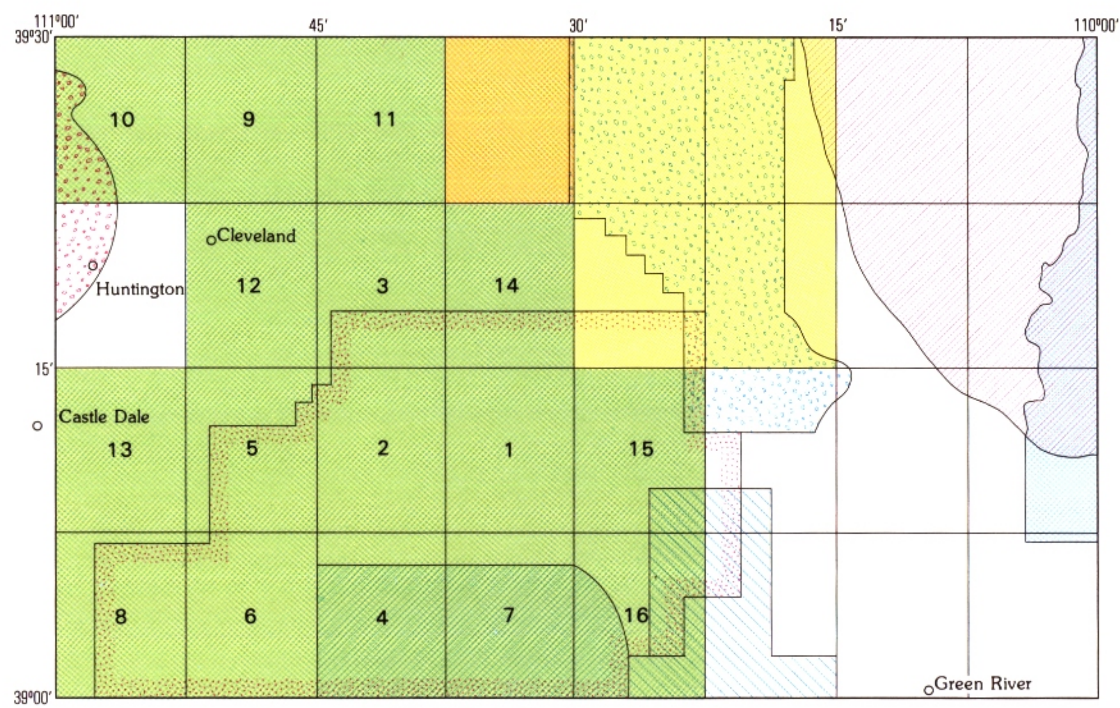


Figure 2.—Sketch map showing regional physiographic features of the Huntington 30' × 60' quadrangle.



SOURCES OF GEOLOGIC DATA
Colors and patterns correspond to numbered references

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INTRODUCTION

The U.S. Geological Survey is engaged in a broad program of field studies designed to present the geologic framework of the United States on easily read topographic maps. The maps selected as a base for these geologic data are part of the Army Map Service (AMS) series of 1° × 2° quadrangles at a scale of 1:250,000. The Price, Utah, AMS 1:250,000-scale quadrangle is one of these maps (fig. 1). For certain areas, however, chiefly those sectors of the country involved in the Geological Survey's coal exploratory program, the geologic data are being compiled on newly developed base maps at a scale of 1:100,000. On these new maps, the configuration of the land is shown by metric contours at a 50 m contour interval. One of these new maps has been used as a base for this geologic map of the Huntington 30′ × 60′ quadrangle, the southeastern quadrangle of the four quadrangles that together make up the Price 1° × 2° sheet.

THE PRICE, UTAH, 1° × 2° AMS (1:250,000-SCALE) QUADRANGLE

The geologic data compiled on the Huntington quadrangle are part of a much larger geologic pattern best displayed on the Price, Utah, 1° × 2° quadrangle. The Price quadrangle includes within its borders parts of three major physiographic provinces: the Colorado Plateaus, the Basin and Range, and the middle Rocky Mountains. Most of the Price quadrangle, including the middle and eastern parts, overlies the west margin of the Colorado Plateaus. Within this part of the Plateaus are the southern edge of the Uinta Basin (expressed as the southward-facing, sinuous escarpments formed by the Book and Roan Cliffs), the northern part of the Canyonlands Section (expressed by the northeast-trending San Rafael Swell), and the northernmost of the High Plateaus of Utah (the Wasatch Plateau). The western part of the Price quadrangle includes the east edge of the Basin and Range Province (the Great Basin). A small wedge of the Middle Rocky Mountains Province—the southern Wasatch Mountains—dominates the northwest corner of the quadrangle.

THE HUNTINGTON, UTAH, 30′ × 60′ (1:100,000-SCALE) QUADRANGLE

COLORADO PLATEAUS PROVINCE

The Huntington quadrangle, within the Colorado Plateaus Province, contains three major physiographic subdivisions (fig. 2): (l) The north end of the San Rafael Swell, in the center of the quadrangle, (2) the sinuous south margin of the Uinta Basin expressed by parts of the imposing Book Cliffs, along the east edge of the quadrangle, and (3) Castle Valley, a broad, lowland, along the west edge of the quadrangle.

San Rafael Swell

The San Rafael Swell is a broad asymmetric northeast-trending upwarp about 115 km (70 mi) long and some 50 km (30 mi) across. This upwarp is but part of a much larger, doubly plunging anticline—the San Rafael anticline—that also trends northeast and that extends far beyond the swell. The anticline has greatly influenced the surrounding rocks. Although the swell (the physiographic unit) and the anticline (the structural unit) are commonly viewed as one and the same feature (because they coincide locally), they are, in fact, wholly different.

North end of the San Rafael Swell

The north end of the San Rafael Swell, the salient physiographic feature in the Huntington quadrangle, appears as a broad wedge with a north-pointing apex that divides the quadrangle into three unequal parts. The wedge is flanked on the west by northeast-trending Castle Valley, and on the east by an unnamed northwest-trending valley (traversed by U.S. Highway 6). The north end of the swell is composed of Triassic and Jurassic red beds that contrast strikingly with the bordering and encircling beds of drab-gray shale and sandstone of Cretaceous age that underlie the valleys.

San Rafael anticline

The axis of the San Rafael anticline, although sinuous in detail, trends about N. 20° E. and coincides with the crest of the swell. Near the northern end of the swell, directly south of the Huntington quadrangle, the axis bifurcates and forms two anticlinal axes that trend northerly. The westernmost axis, the major axis, trends almost due north, extending along the east edge of Cedar Mountain, and continues past Mounds toward the Book Cliffs. The eastern axis, a minor fold, trends about N. 25° E. and heads toward Woodside. In general, this bifurcation has had little effect on the gross structure of the swell. Strata on the west flank of the swell commonly dip gently 2° to 6° westward; by contrast, those on the east flank commonly dip steeply 45° to 85° eastward to form an imposing monocline. Locally, the strata along the east flank are vertical or overturned (Hawley and others, 1968, p. 29).

The San Rafael anticline has exerted a powerful influence on the rocks beyond the swell, perhaps best seen in the Book Cliffs, north of this quadrangle. In that area the slow but continued growth of the anticline during post-Cretaceous time arched a widespread bleached zone, the Cretaceous-Tertiary boundary, that was once near horizontal (T.D. Fouch, U.S. Geological Survey, oral commun., 1981; see also description of the Flagstaff Member of Green River Formation and North Horn Formation). This slow but persistent anticlinal growth, in addition, has influenced the pattern of distribution of the Cretaceous and Tertiary rocks in the Book Cliffs; the strata thin toward the anticlinal axis, and thicken away from it.

Age of the San Rafael Swell

Firm evidence for the time of the development of the San Rafael Swell is lacking. Gilluly (1929, p. 126) inferred that the swell was formed at some time after the Cretaceous, because Cretaceous strata are involved in the folding, and because of the structural similarity between the swell and the Waterpocket fold (where folded Cretaceous strata are unconformably overlain by near-horizontal Eocene beds). Hunt (1956, p. 73-77) has proposed that the folding and uplift of the swell began during the early Paleocene and persisted through the Miocene. Hawley and others (1968, p. 37-38) suggested that the swell likely was arched during the early Tertiary. They base this age on the physiographic similarity between the monocline developed along the east flank of the swell and a comparable one (the Wasatch monocline) formed along the west flank of the Wasatch Plateau that Spieker (1949) has dated as Paleocene. Other workers provisionally place the development of the swell at some time between the late Miocene and early Pliocene (Cohenour, 1969, p. 239). As noted above, in the Book Cliffs, Upper Cretaceous strata thin toward the axis of the San Rafael anticline; this suggests that the anticline (and thus, the swell) had begun to form during or prior to Late Cretaceous time. Presumably the anticline continued to grow slowly throughout the Paleocene and Eocene. Possibly it continued its uninterrupted growth into the Miocene, although some geomorphic evidence opposes this view. For example, during the Miocene, a time of considerable structural unrest, some streams on the Colorado Plateaus were displaced laterally as new structural features developed and grew (Hunt, 1956, p. 82). Thus, the Dolores River appears to have been displaced eastward as La Sal Mountains grew; in like fashion the Dirty Devil River appears to have been shifted northeastward off the developing Henry Mountains. By contrast, the San Rafael and Muddy Rivers, which cut through the San Rafael Swell, have not been displaced laterally but appear to have maintained their original southeasterly course. I interpret this to mean that during the Miocene these streams dropped from an older upland, long since removed, onto a stable and previously formed upwarp—the San Rafael Swell.

It seems reasonable to conclude that the swell was formed at some time during the early Tertiary; it may have continued to grow during middle Tertiary time but probably was a stable element during the late Tertiary.

Older concealed structure

The northeast-trending San Rafael anticline is superimposed on an older northwest-trending anticlinal fold that extends from the Orange Cliffs northwestward at least to the San Rafael Swell (McKeown and Orkild, 1958, p. 51 and fig. 4). (The Orange Cliffs are near the junction of the Green and Colorado Rivers, about 115 km (70 mi) southeast of the swell.) This older fold, flanked by a belt of unusually thin Moenkopi, may be "* * * related to northwest-trending structural features of the salt anticline region of the Paradox Basin" (Hawley and others, 1968, p. 38).

South margin of the Uinta Basin

The Uinta Basin is a large eastward-trending basin that covers about 25,900 sq km (10,000 sq mi) in northeastern Utah. It is bordered on the north by the Uinta Mountains, on the west by the Wasatch Range, on the east by the Douglas Creek arch, and on the south by much of the Canyonlands Section. Structurally the basin is an asymmetric syncline, and its gently dipping southern margin, part of which is within this quadrangle, dips northward into the center of the basin.

The southern margin of the Uinta Basin appears as steep, sinuous escarpments known as the Book and Roan Cliffs. These escarpments are underlain by sandstone and shaly siltstone beds of Cretaceous and Tertiary age. In the Huntington quadrangle a segment of these escarpments is east of the San Rafael Swell and forms the Beckwith Plateau and adjacent uplands to the north. To the west (beyond the Huntington quadrangle) these beds form the imposing cliffs that mark the east flank of the Wasatch Plateau.

Castle Valley

Castle Valley follows the structural low between the Wasatch Plateau on the west and the San Rafael Swell on the east. Southeast-flowing streams, debouching from the Wasatch Plateau, furnish water to small communities scattered along the valley floor. The valley supports a few cattle ranches and small farms, but many of the residents depend upon the nearby coal mines (dug in coal beds exposed along the east face of the Wasatch Plateau) for their livelihood. Price, one of the largest cities in this part of central Utah, is at the north end of Castle Valley (northward beyond the limits of this quadrangle).

STRUCTURE

FAULTS

Most of the faults that break the rocks in the Huntington quadrangle appear to be within a broad belt that extends from the Book Cliffs, on the east, westward across the San Rafael Swell to Castle Valley, on the west. East of the Book Cliffs and west of Castle Valley only a few faults are found. All faults are normal, and are characterized by high to moderate dips. Most of the faults strike northwest or westerly. A few faults marked by northeast and northerly strike are along the west flank of the swell.

Northwest- and west-striking faults

In the southern and middle parts of the quadrangle the faults strike about N. 50° W., but farther north, they gradually change strike to almost due west. Most of these faults are linear features, but a few are slightly curved; they average 8 km (5 mi) in length, with some as much as 15 km (9 mi) long. In detail, some parts of the west-striking faults curve gently to the south and strike southwesterly.

The northwesterly striking faults are conspicuous and appear to be a continuation of the northwest-striking faults and grabens that characterize both the area between the Green and Colorado Rivers (directly southeast of the Huntington quadrangle) (McKnight, 1940, p. 120), and the Paradox Basin, still farther to the southeast.

North- and northeast-striking faults

Much less conspicuous are a few discrete high-angle normal faults that strike generally northerly. These faults, restricted chiefly to the rocks along the west flank of the swell, are distinct linear breaks with strikes that range from almost due north to about N. 20° E. Most are about 5 km (3 mi) long, although one near the center of the quadrangle is as much as 15 km (9 mi) long. In strike, length, and general appearance they are much like the many normal faults that break the rocks along the crest and west flank of the Wasatch Plateau (Witkind, Weiss, and Brown, 1986).

Grabens

Some of the northwest-striking faults are paired to form grabens, of which the largest and most conspicuous is the Cottonwood graben, followed by Cottonwood Wash, near the south edge of the quadrangle, west of U.S. Highway 6. The graben strikes about N. 50° W., maintains a remarkably uniform width of about 1,000 m (3,300 ft) for most of its length, and is about 18 km (11 mi) long. Of this length, about 8 km (5 mi) is within the Huntington quadrangle; the remaining 10 km (6 mi) is within the Salina quadrangle to the south (Williams and Hackman, 1971). Displacement along the boundary faults does not exceed 100 m (300 ft).

All other grabens are small; most are about 4 km (2.5 mi) long and 300 m (1,000 ft) wide. Displacement along the boundary faults commonly does not exceed 30 m (100 ft).

Age relations

Clear-cut evidence to indicate the age relations between the northwest-striking and north-striking faults is lacking; possibly both were formed synchronously.

The fact that most of the faults trend northwest across the swell apparently independent of the swell's northeast strike argues strongly that these faults, at least, are younger than the arching of the swell. Gilluly (1929, p. 125) suggested that some of the northwest-striking faults, in the area covered by the Huntington quadrangle, "* * * are due to nearly vertical readjustment later than the principal folding * * *"

The absolute age of the faults is also uncertain. A few of the northwest-striking faults cut beds as young as the Colton Formation of Eocene age implying that the faults are post-Eocene or younger.

Origin of the faults and grabens

The majority of the northwest-striking faults and grabens in the Huntington quadrangle are collinear with, and appear similar to the northwest-striking faults and grabens of the Paradox Basin southeast of the Huntington quadrangle. This suggests that all are related and are part of a northwest-trending zone of faults that extends from the Paradox Basin on the southeast to the center of the Huntington quadrangle on the northwest. Seemingly, all faults in the zone were formed at about the same time and in response to the same stresses. As the faults and grabens in the Paradox Basin are clearly salt-generated structures, likely the faults and grabens in the Huntington quadrangle have a similar origin, formed presumably as a result of salt withdrawal or flowage at depth.

In the Huntington quadrangle, the western limit of this postulated northwest-trending fault zone coincides with the west flank of the San Rafael Swell. Faults of northwest strike are not found beyond this area. The abrupt end of the northwest-trending fault zone is puzzling; it may reflect the subsurface pinch-out of the Paradox salt, and so delineate the northwest flank of the Paradox Basin. This explanation is supported by the coincidence between the western limit of the fault zone and the distal western edge of the Paradox Basin as outlined by Baars and Stevinson (1981, fig. 3).

The origin of the north- and northeast-striking faults is also unclear. As these faults are like the many north- and northeast-striking faults on the crest of the Wasatch Plateau (west of the Huntington quadrangle), all may be related. The Wasatch Plateau faults may stem from withdrawal of salt contained in the Middle Jurassic Arapien Shale (Stokes, 1952; Stokes and Holmes, 1954; Witkind, Weiss, and Brown, 1986). The eastern limit of the salt contained within the Arapien Shale is uncertain. In the past, the zero isopach has been drawn near the eastern edge of the Wasatch Plateau (Moulton, 1975, fig. 13; Stokes, 1982, fig. 1), some 27 km (17 mi) west of the faults in the Huntington quadrangle. Possibly small stringers of salt persisted eastward beyond the previously inferred edge of the salt, and partial or complete dissolution of these small stringers may have resulted in the few north- and northeast-striking faults that break the rocks along the west flank of the San Rafael Swell.

COLLAPSE STRUCTURES

Three small collapse structures are near the mouth of Buckhorn Wash, near the south edge of the map. For ease of identification each is marked on the map with a capital C. Two, close together, are about 1.5 km (1 mi) east of Window Blind Peak; the third is about 3 km (2 mi) east of the peak near the confluence of Red Creek with the San Rafael River. All are much alike. Each is crudely circular to oval in plan, about 60 m (200 ft) in diameter, and each contains a mass of altered, fractured rock that seems to have subsided or collapsed into the central part of the structure. Strata of the host formations, which encircle these structures, dip inward toward the center of the structures. Some of the brecciated clasts within the collapse structures were derived from the host formations.

Johnson (1957, p. 46) suggested that the collapse structures were formed when either hot ascending waters or ground water dissolved some of the underlying Paleozoic carbonate formations, causing the overlying units to fail and subside into the resultant voids. Sugiura and Kitcho (1981, p. 42) modified this interpretation somewhat. They proposed that dissolution of soluble subsurface units, presumably either carbonates or salt, caused an initial cavity in the subsurface. Continued solution stoped the overlying strata until the collapse structure reached the surface. These collapse structures, according to Sugiura and Kitcho (1981, p. 42), probably formed during early Tertiary time, concurrently with the development of the San Rafael anticline.

Elsewhere in the San Rafael Swell some minor radioactivity is associated with the rocks in these structures, but none was noted in any of the three collapse structures near Window Blind Peak.

Larger and more complex collapse structures exposed in the southern part of the San Rafael Swell have been described by Hawley and others (1968), Keys and White (1956), and Kerr and others (1957).

SURFACE-WATER RESOURCES

Details about the surface-water resources of the Huntington quadrangle are contained in a companion publication, U.S. Geological Survey Miscellaneous Investigations Series Map I-1514 (Price, 1984).

ECONOMIC DEPOSITS

MINERAL FUELS

Coal

A series of thick coal beds is exposed in the western Book Cliffs and along the east face of the Wasatch Plateau. These coal beds are within the Blackhawk Formation, an eastward-pointing wedge of strata dominated by a series of littoral marine sandstones that thin eastward and that eventually grade into the Mancos Shale. Between these sandstones are continental coal-bearing shale and siltstone beds; the coals within these shale and siltstone beds give economic significance to the Blackhawk.

The Blackhawk was formed in a coastal area where eastward- and southeastward-flowing streams emptied into swamps, lagoons, and estuaries of a Cretaceous sea. The environment in which the Blackhawk was deposited has been interpreted as a wave-dominated delta that supported extensive swamps rich in organic material (Balsley, 1980). The organic material in these swamps eventually gave rise to the coal beds.

These coal beds have been and are being mined extensively in the Sunnyside area directly north of this quadrangle, in the Helper-Hiawatha area directly northwest, and in the Huntington-Castle Dale area directly to the west. The coal beds are thick in those areas, but they thin eastward and pinch out. Of the various coal beds in the Blackhawk Formation only the uppermost one—the Sunnyside coal, about 6 m (20 ft) thick near Sunnyside—seemingly persists into this quadrangle gradually thinning eastward. Near Sunnyside the bed splits to form the Upper and Lower Sunnyside coal beds. As the Upper Sunnyside bed is traced southward along the westward-facing sector of the Book Cliffs (east of the San Rafael Swell) the bed splits to form two to three thin coal seams, and near the Beckwith Plateau (southeast corner of the quadrangle) these seams are interleaved in a shale sequence (Young, 1955). None of these coal seams is much more than 1 m (4 ft) thick and they probably have little commercial potential.

The coals throughout the area are much alike; they rank as high-volatile B bituminous. Sulfur content is low, ranging from 1 to 3 percent. BTU/lb averages 12,762 (Doelling, 1972, p. XVIII).

Doelling (1972) discussed the distribution and nature of the coal beds in this general region; Spieker (1931) has discussed the distribution of the coal beds on the Wasatch Plateau. Balsley (1980) and Young (1976) described the depositional environments in which these coal beds formed.

Uranium deposits

Uranium deposits occur in the Chinle Formation in the northern part of the San Rafael Swell but are small and low grade. The larger and richer deposits, for which the swell is noted, are confined to the southern part of the swell, and to a very localized area near Temple Mountain (Hawley and others, 1965). (The Temple Mountain area is along the east edge of the swell, some 55 km (35 mi) southwest of the community of Green River) The few mines in the Huntington quadrangle are concentrated on the first mesa (known locally as Calf Mesa) west of Window Blind Peak, near the mouth of Buckhorn Wash. These mines, which make small shipments every now and then, tap low-grade uraniferous deposits localized in conglomeratic sandstones of the Moss Back Member of the Chinle Formation.

The deposits lie mainly parallel to the bedding and are confined to a narrow zone in the basal part of the Chinle. They appear to be localized in sandstone and conglomeratic sandstone that fill broad and shallow, northwest-trending channel scours cut into the upper part of the underlying Moenkopi Formation. The channels, thus, have cut through the purple-white zone (see description of the Chinle Formation), and the presence or absence of the zone assists in the search for the channels. The ore bodies appear to be closely associated with either carbonized wood or asphaltic material.

Although uraniferous rocks have been found in various other units besides the Chinle, none of these deposits are of economic significance.

Of the three belts of ground favorable for the localization of uranium deposits outlined by Hawley and others (1968, p. 58), only the northernmost belt extends into the Huntington quadrangle. This belt, at least 11 km (7 mi) wide, trends northwest and appears to follow closely the northeast flank of the old northwest-trending fold that is concealed beneath the San Rafael anticline. The fact that very few channels are found in the northern part of the swell, as evidenced by the almost unbroken purple-white zone overlying the Moenkopi, suggests that this sector of the swell is relatively unfavorable for uranium prospecting and is unlikely to contain any significant uranium deposits.

Some workers (Hawley and others, 1968, p. 119) who have studied the much larger collapse features in the Temple Mountain area believe that the uranium deposits were formed from uraniferous aqueous solutions brought in through the collapse structures (see above). Others (Hess, 1933 p. 457; Johnson, 1957, p. 49), however, have suggested that the uranium deposits were formed prior to the development of the structures.

OIL AND GAS

In the Huntington quadrangle the northern end of the San Rafael anticline seems the structure most likely to contain oil and gas. Evidence of petroleum is widespread. Asphaltite (presumably a derivative of petroleum) is found throughout much of the lower part of the Chinle Formation. An asphalt-base oil impregnates rocks in the Temple Mountain district (Hawley and others, 1965). Large areas of the Moenkopi Formation are bleached a greenish gray, probably the result of the reducing effects of petroleum and natural gas (Johnson, 1957, p. 45). Good shows of oil and gas have been found in tests that have penetrated various Paleozoic units, and many of the Mesozoic units, notably the Sinbad Limestone Member of the Moenkopi Formation, are oil stained. Much hydrocarbon gas has been found in lenticular beds of the Ferron Sandstone Member of the Mancos Shale, chiefly in small fields on the Wasatch Plateau directly west of this quadrangle. And in a few places, notably the Grassy Trail area (near Wellington, about 11 km (7 mi) southeast of Price), small amounts of oil have been found (Mahoney and Kunkel, 1963, p. 372). In addition, helium has been recovered from the Woodside anticline. Despite these favorable signs the area has not been productive and remains a disappointment.

Among those strata considered likely to contain oil are the Kaibab Limestone (Permian), the Cedar Mesa Sandstone Member of the Cutler Formation (also called Coconino Sandstone; Permian), and the Sinbad Limestone Member of the Moenkopi Formation (Triassic). All contain dead-oil stains or shows of live oil. Gas accumulations are likely in the sandstone facies of the Chinle Formation, and in the Navajo and Wingate Sandstones. The Ferron Sandstone Member of the Mancos Shale produces both hydrocarbon and carbon dioxide gas in nearby areas. Likely some of these beds are good reservoir rocks because they are highly fractured and not because of inherent primary porosity.

Structural traps

Mahoney and Kunkel (1963, p. 357) suggested that a concealed major fold or positive area of pre-Laramide age may trend northwestward across the swell. They based this suggestion chiefly on the almost complete absence of Pennsylvanian rocks on the crest of the swell and the fact that Mississippian and Pennsylvanian rocks thicken both northeastward and southwestward away from the crest of this postulated fold. Possibly this structure coincides in trend and position with the northwest-trending fold recognized by McKeown and Orkild (1958). Small pools of oil and gas may have accumulated in a series of minor stratigraphic and structural traps that were formed along the flanks of this older fold (Mahoney and Kunkel, 1963, p. 371)

In this quadrangle, four small folds—the Woodside, Mounds, Farnham, and Huntington anticlines—may play significant roles in the accumulation of oil and gas. The Woodside, Mounds, and Farnham folds are superimposed on the much larger San Rafael anticline; the Woodside structure is along the northeast flank of the anticline and the Mounds and Farnham structures are on the northern end of the anticline. The Huntington anticline is along the west side of Castle Valley at the base of the east flank of the Wasatch Plateau. Major features of these folds are discussed below; additional details are presented in Mahoney and Kunkel (1963), Kuehnert (1954), and in the publication "Oil and gas fields of Utah—a symposium" (Anonymous, 1961).

Woodside anticline

The Woodside anticline, along the northeast flank of the San Rafael Swell, is about 30 km (20 mi) northwest of Green River. The anticline occupies parts of Tps. 18 and 19 S., Rs. 13 and 14 W. in Emery County. U.S. Highway 6 passes along its east flank. The anticline is asymmetric, about 11 km (7 mi) long, and about 5 km (3 mi) wide at its maximum width. It forms a gentle curve concave to the east with its northern axis trending about N. 15° E., and its southern axis trending about S. 15° E. Strata along the west flank of the anticline dip about 15° westward; those along the east flank dip about 5° eastward Structural closure is about 245 m (800 ft) (Gilluly, 1929, p. 123). Drilling during the 1920's discovered carbon dioxide and helium-rich gas in the "Coconino" Sandstone (i.e., Cedar Mesa Sandstone Member of the Cutler Formation of this report) with production at the rate of 6 to 10 million cubic feet per day (Mahoney and Kunkel, 1963, p. 371). In 1924 the U.S. Government set the area aside as Helium Reserve No. 1. A test of deeper Paleozoic formations has been fruitless.

Mounds anticline (subsurface)

The Mounds anticline is at the north tip of the swell, but is not expressed at the surface. It was found as a result of seismic surveys and subsurface well data (Mahoney and Kunkel, 1963, p. 372). The anticline is broken by a fault; structural closure is about 150 m (500 ft) (Peterson, 1954, p. 86). Although the structure has been tested several times, only small shows of oil and gas have been noted, chiefly in Moenkopi strata. Small amounts of oil, however, have been found in the Grassy Trail area some 6 km (4 mi) to the east, but whether the Mounds structure extends that far to the east is unknown.

Farnham anticline

Only the southern tip of the Farnham anticline is within this quadrangle. The anticline, about 8 km (5 mi) east of Wellington, occupies parts of Tps. 14 and 15 S., Rs. 11 and 12 E., and trends about N. 25° E. It is about 8 km (5 mi) long and about 5 km (3 mi) wide at its maximum width. The anticline is broken by a series of northeast-trending high-angle normal faults with the rocks east of the faults being downthrown. Peterson (1954, p. 86), on the basis of seismic and subsurface data, interpreted these faults as low-angle eastward-directed thrusts. Peterson (1961) suggested that the dome reflects and is underlain by a low-angle eastward-directed thrust fault. The Navajo Sandstone is the producing reservoir, and carbon dioxide is the principal product.

Huntington anticline

The Huntington anticline, astride the west edge of this quadrangle, is about 6 km (3.5 mi) northwest of the town of Huntington. The anticline lies at the base of the eastern edge of the Wasatch Plateau. Only the northern half of the anticline, trending about N. 25° E., is within this quadrangle; the southern half of the anticline, within the Manti quadrangle (to the west), trends about N. 10° W. The anticline, thus, has the shape of a gentle arc concave to the east. It occupies parts of Tps. 16 and 17 N., R. 8 E. in Emery County, and is about 16 km (10 mi) long and 5 to 6 km (3 to 4 mi) wide. Structural closure is about 200 m (650 ft) (Kuehnert, 1954). The anticline is symmetrical with dips of 6° to 8° common along each flank; in detail, the anticline consists of two highs separated by a shallow saddle. The anticline has been tested and shows of oil and gas were found in the Ferron Sandstone Member of the Mancos Shale, the Moss Back Member of the Chinle (misidentified as "Shinarump" Member by some), and the Sinbad Limestone Member of the Moenkopi Formation (Kuehnert, 1954). Details about the anticline and the sedimentary units penetrated are given by Kuehnert (1954).

NONMETALLIC MINERAL DEPOSITS

Gypsum deposits

Large amounts of gypsum, in lenticular beds and thin lenses, are in the Carmel and Summerville Formations (Lupton, 1913). In the Huntington quadrangle most of the gypsum deposits in the Carmel are along the west flank of the swell in as many as seven thin, lenticular beds in the upper part of the formation (Gilluly 1929, p. 101). Although the Carmel gypsum beds range in thickness from 0.3 to 9 m (1 to 30 ft), the great majority are much thinner than 9 m (30 ft), rarely exceeding 1.5 m (5 ft) in thickness. Stokes (1982, p. 10) reports that a bed of gypsum as much as 18 m (60 ft) thick, presumably within the Carmel Formation, is exposed along the west flank of the swell. The gypsum beds in the Summerville Formation are also lenticular, but the gypsum is less pure than the Carmel gypsum, and is in smaller, less abundant, and thinner lenses that average only 1.5 m (5 ft) in thickness.

Even though large deposits of gypsum are in the quadrangle, their thinness and lenticularity, plus the very long distances required to bring them to manufacturing facilities, suggest that none of these deposits are worth mining under current economic conditions.

Sand and gravel deposits

A mantle of unconsolidated to well-cemented water-laid detritus caps the many spectacular pediments that encircle the north end of the San Rafael Swell. This material, mapped as pediment mantle (**QTpm**), constitutes an almost inexhaustible supply of sand and gravel. The deposits hold up large, broad, even-surfaced benches, mesas, and buttes whose slopes are inclined gently toward the swell from the Book Cliffs on the east and north, and from the Wasatch Plateau on the west. The deposits consist of crudely sorted mixtures of angular to subround clasts that range in size from silt to boulders. The clasts, derived from the Book Cliffs and the Wasatch Plateau, reflect the soft shale, shaly siltstone, and sandstone that make up those land masses.

Locally sand and gravel pits have been opened in these deposits; the material is used chiefly for road metal, fill, and concrete aggregate. Because the deposits are poorly sorted and contain much soft material, much of the material must be crushed, screened, and washed, before it can be used for some construction projects.