

**CORRELATION OF MAP UNITS**

Qa	Qc	Qd	Holocene	
Qp	Qb	Qe	Quaternary	
Qpc	Qpb	Qc	Pleistocene	
Tc	Td	Tf	Eocene	TERTIARY
TKfn			Eocene and Paleocene	
Kpm	Kpn	Kps	Unconformity	
Kc	Kb	Ka	Unconformity	
Kmsu	Kmsl	Kmf	Upper Cretaceous	CRETACEOUS
Kmb	Kma	Kml	Upper and Lower Cretaceous	
Kd	Kca	Kcb	Upper and Lower Cretaceous	
Kch	Kcm	Kcn	Upper Jurassic	JURASSIC
Jm	Jl	Jk	Upper Jurassic	
Jc	Jb	Ja	Upper and Middle Jurassic	
Jcau	Jca	Jcb	Upper and Middle Jurassic	

**DESCRIPTION OF MAP UNITS**

**YOUNGER SURFICIAL DEPOSITS (HOLOCENE)**

- Qa Stream alluvium - Mostly sand (some silt) deposited by modern streams; very thin deposits not mapped. As thick as 30 feet
- Qc Gravel - Thin deposits derived locally, mostly from sandstone and limestone boulders, pebbles, and cobbles in pediment veneer. As thick as 15 feet
- Qd Stream terrace deposits - Sand, silt, gravel, and boulders derived from units upstream from the deposits; comprise isolated remnants, mostly above the present course of the Price River and its abandoned channels. Thickness 10 feet or more
- Qe OLDER SURFICIAL DEPOSITS (PLEISTOCENE - WISCONSIN AGE)
- Qpc Alluvial fan deposits - Sand, silt, clay, and soil, intermixed with boulders from units throughout the stratigraphic section. As thick as 50 feet
- Qc Colluvium and slope-wash deposits - Loose to slightly cohesive sand, silt, and clay containing rock fragments; cover steep slopes above valley floors. Thin deposits not mapped. Thickness 10-50 feet

**PEDIMENT DEPOSITS (PLEISTOCENE)**

- Qp All units contain unsorted silt, sand, and rock fragments as big as large boulders. As thick as 50 feet
- Qpa Pediment deposits undivided
- Qpb Unit A - Youngest, topographically lowest deposit; loosely cohesive; calcic only on boulder surfaces
- Qpc Unit B - Poorly cemented; thin calcite near top; comprises eroded remnants of a unit at higher elevations than unit A
- Qpd Unit C - Oldest, topographically highest deposit; firmly cemented; calcite near the top; comprises erosional remnants of unit B

**COLTON FORMATION (EOCENE)** - Thickness as much as 3,000 feet

- Tc Colton Formation undivided
- Td Upper member - Sandstone and siltstone beds, mostly maroon; forms cliffs and very steep slopes
- Tf Lower member - Channel and lens-shaped siltstone deposits interbedded with mudstone; mostly gray and maroon; beds thinner than in the upper member; forms ledges and steep slopes

**FLAGSTAFF LIMESTONE (EOCENE) AND PALEOCENE AND NORTH HORN FORMATION (PALEOCENE AND UPPER CRETACEOUS)** - Interbedded siltstone, sandstone, mudstone, and limestone; individual lithologic units mostly thin and lens shaped; form gentle slopes and ledges. Deposited in lakes and flood plains; limestone beds locally very rich in invertebrate fossils. Thickness 500-800 feet

**PRICE RIVER FORMATION OF MESAVERE GROUP (UPPER CRETACEOUS)**

- Kpb Bluecast Sandstone Member - Fine to medium-grained sandstone, a single bed composed of fluvial channel-fill deposits; forms steep cliffs and ledges. Thickness 75-250 feet
- Kpm Mudstone member - Interbedded and discontinuous mudstone, siltstone, and sandstone, mostly dark gray to dark brown; forms slopes and low ledges. Locally contains vertebrate fossils. Thickness 100-400 feet
- Kc CASTLEGATE SANDSTONE OF MESAVERE GROUP (UPPER CRETACEOUS) - Fine to medium-grained sandstone, local concentrations of clay galls at various horizons; forms high, abrupt cliff and bare sandstone dip slopes. Thickness 80-300 feet
- Kbs BLACKHAWK FORMATION OF MESAVERE GROUP (UPPER CRETACEOUS)
- Kba Upper mudstone member and Sunnyside Member - Upper mudstone member; mudstone and discontinuous sandstone, siltstone, and claystone of continental and marine origin; Sunnyside coal bed at base. Sunnyside Member: arenaceous siltstone and very fine grained to medium grained sandstone, grading downward from coarser to finer; forms abrupt cliff (middle part of Book Cliffs); sharp upper contact and transitional lower contact. Thickness of entire unit 150-300 feet
- Kbl Lower mudstone member and Kenilworth Member - Lower mudstone member; mudstone and discontinuous siltstone, sandstone, and claystone of continental and marine origin; Kenilworth coal bed at base. Kenilworth Member: arenaceous siltstone and very fine grained to medium grained sandstone, grading downward from

coarser to finer; composed of three distinct sandstone beds, each separated by dark-gray mudstone and siltstone; forms lower part of Book Cliffs; upper contact sharp; lower contact transitional. Thickness of entire unit 150-300 feet

Lower tongue of Aberdeen Member - Very fine grained sandstone, siltstone, and claystone containing much carbonaceous debris; forms low crests a few hundred feet below the base of the Book Cliffs within the Mancos Shale outcrop (see diagrammatic cross section). Thickness 0-50 feet

**MANCOS SHALE (UPPER CRETACEOUS)**

Kma Main body - Dark-gray fissile mudstone containing discontinuous layers of claystone and tiny concretions; very deeply weathered; very slick when wet. About 3,000-4,000 feet thick; may be as much as 5,000 feet thick north of the large northwest-trending subsurface fault

Kmsu Upper sandstone bed - Lithologically similar to Ferron Sandstone Member. Thickness 0-10 feet

Kmf Ferron Sandstone Member - Fine grained to very fine grained sandstone, rich in organic debris; forms abrupt cliffs and low crests. About 30 feet thick near Woodside; thickens northward; contains a thin bed of limestone. Thickness 150-250 feet

Kml Lower sandstone bed - Lithologically similar to Ferron Sandstone Member. Thickness 0-15 feet

**DAKOTA SANDSTONE (UPPER AND LOWER) (CRETACEOUS)**

Kd Fine to medium-grained sandstone and conglomerate; some discontinuous mudstone beds; caps hogbacks and makes small outliers in the western part of quadrangle. Thickness 20-100 feet

**CEDAR MOUNTAIN FORMATION (LOWER CRETACEOUS)**

Kca Variegated mudstone and claystone containing small discontinuous lenses of fine-grained sandstone; forms slopes and thin ledges. Thickness 150-250 feet

Kcb Backhorn Conglomerate Member - Fine to medium-grained sandstone and interbedded pebble conglomerate; forms low crests, steep bluffs, and long dip slopes. Thickness 10-80 feet

**MORRISON FORMATION (UPPER JURASSIC)**

Jmb Bushy Basin Shale Member - Variegated mudstone and siltstone containing thin discontinuous lenses of fine-grained sandstone and fresh-water limestone; forms low slopes and swales. Thickness 150-250 feet

Jms Salt Wash Sandstone Member - Fine to coarse-grained dark-brown to yellow sandstone. Thickness 150-225 feet

**SIMMERVILLE FORMATION (UPPER JURASSIC)**

Jc Interbedded mostly chocolate-brown mudstone and fine-grained sandstone; variably resistant to weathering; forms bluffs and slopes. Contains vesicles of gypsum throughout. Thickness 150-200 feet

**CURTIS FORMATION (UPPER JURASSIC)**

Jl Mostly gray-green mudstone and claystone; forms low slopes and ledges. Light-gray crossbedded sandstone; forms steep slopes and roughly dissected topography. Thickness 150-180 feet

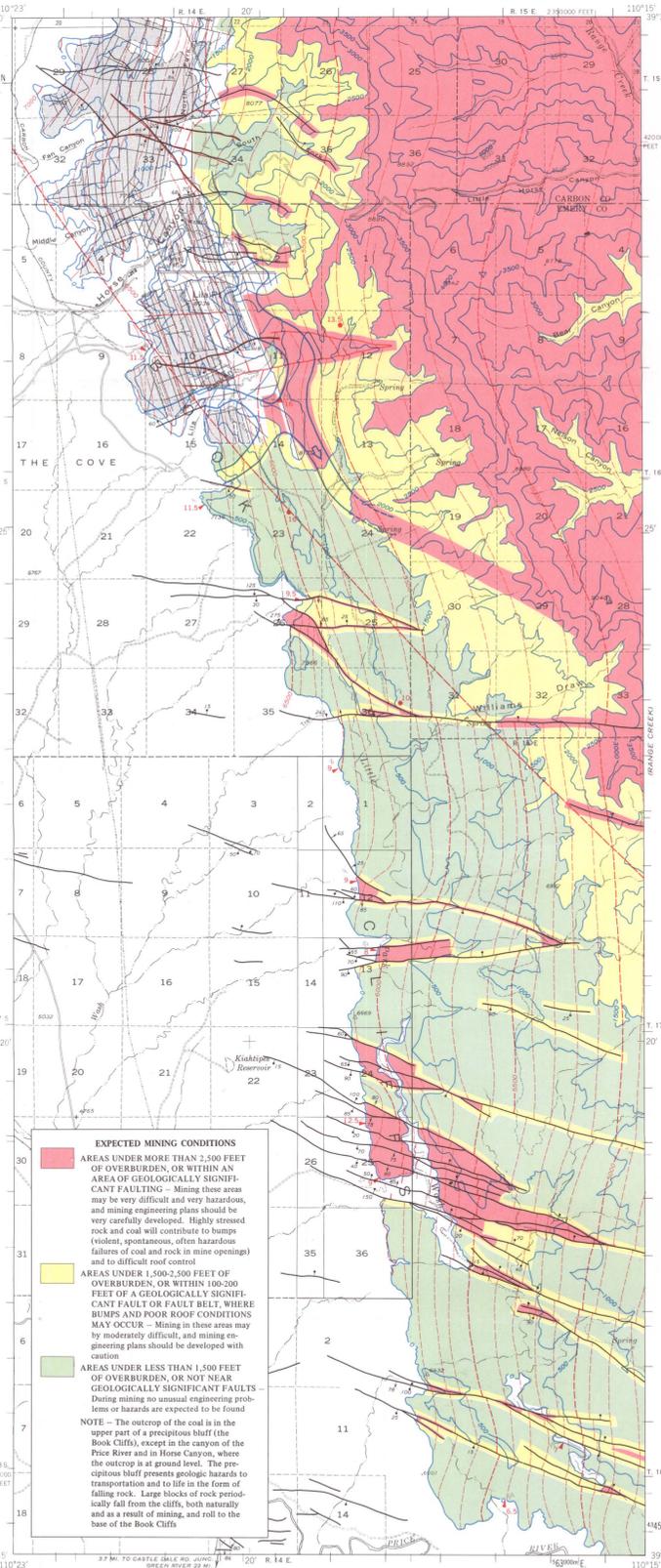
**ENTRADA SANDSTONE (UPPER JURASSIC)**

Jk Fine-grained red sandstone; cross-bedded sets form single bed unit forms distinctive cliffs and bluffs. Base is transitional with underlying unit. Thickness 150-300 feet

**CARMEL FORMATION (UPPER AND MIDDLE JURASSIC)**

Jcau Upper member - Generally soft mudstone and siltstone, containing thin discontinuous sandstone beds and, near base, a thick gypsum bed. Forms swales and slopes and low bluffs. Thickness 150-250 feet

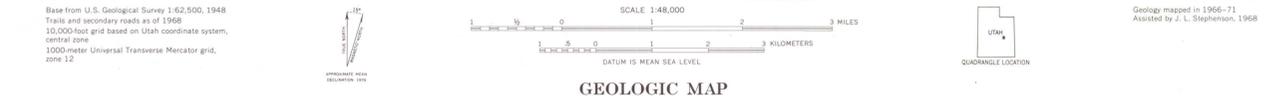
Jca Lower member - Flaggy gray limestone with siltstone, shale, and sandstone interbeds. Thickness 50-100 feet



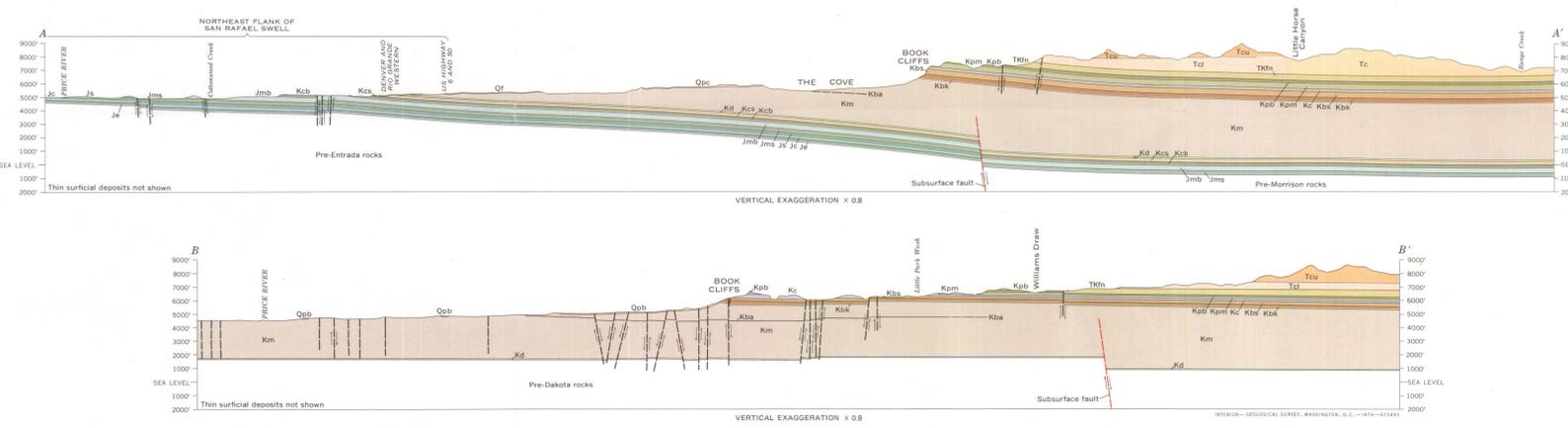
**EXPECTED MINING CONDITIONS**

- AREAS UNDER MORE THAN 2,500 FEET OF OVERBURDEN, OR WITHIN AN AREA OF GEOLOGICALLY SIGNIFICANT FAULTING - Mining these areas may be very difficult and very hazardous, and mining engineering plans should be very carefully developed. Highly stressed rock and coal will contribute to bumps (violent, spontaneous, often hazardous failures of coal and rock in mine openings) and to difficult roof control
- AREAS UNDER 500-2,500 FEET OF OVERBURDEN, OR WITHIN 100-200 FEET OF A GEOLOGICALLY SIGNIFICANT FAULT OR FAULT BELT, WHERE BUMPS AND POOR ROOF CONDITIONS MAY OCCUR - Mining in these areas may be moderately difficult, and mining engineering plans should be developed with caution
- AREAS UNDER LESS THAN 1,500 FEET OF OVERBURDEN, OR NOT NEAR GEOLOGICALLY SIGNIFICANT FAULTS - During mining no unusual engineering problems or hazards are expected to be found

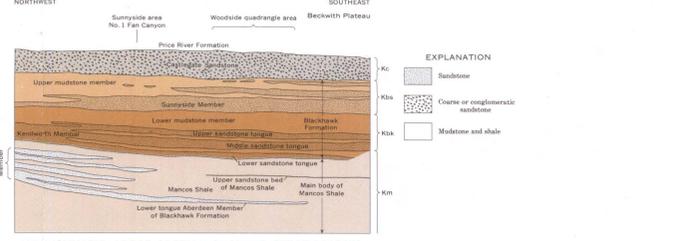
**NOTE** - The outcrop of the coal is in the upper part of a precipitous bluff (the Book Cliffs) except in the canyon of the Price River and in Horse Canyon, where the outcrop is at ground level. The precipitous bluff presents geologic hazards to transportation and to life in the form of falling rock. Large blocks of rock periodically fall from the cliffs, both naturally and as a result of mining, and roll to the base of the Book Cliffs



**GEOLOGIC MAP**



**MAP SHOWING EXPECTED MINING CONDITIONS, BASED ON GEOLOGIC PARAMETERS**



**ENGINEERING GEOLOGIC MAP OF THE WOODSIDE QUADRANGLE, EMERY AND CARBON COUNTIES, UTAH**

By  
Frank W. Osterwald and John O. Mabery  
1974