Utah Geological Survey
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Utah Department of Natural Resources

Plate 1
Utah Geological Survey Map 213
Geologic Map of the Smoky Mountain 30'x60' Quadrangle

SCALE 1:100,000
Topographic contour interval 50 meters
Geologic structure contour interval 100 meters

2 1 0 2 4 6 8 10 Kilometers

2 1 0 2 4 Miles

Base from U.S.G.S. Smoky Mountain 30' x 60' quadrangle, 1983

12.3°
218.6 MILS
2005 MAGNETIC DECLINATION
AT CENTER OF SHEET

UTAH

GEOLOGIC MAP OF THE SMOKY MOUNTAIN 30'x60' QUADRANGLE, KANE AND SAN JUAN COUNTIES, UTAH, AND COCONINO COUNTY, ARIZONA

by
Hellmut H. Doelling and Grant C. Willis

2006

This geologic map was funded by the Utah Geological Survey and the U.S. Geological Survey, National Cooperative Geologic Mapping Program, through USGS STATEMAP award number 98HQAG1521. The views and conclusions contained in this document are those of the author and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

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Cartography: James W. Parker

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Plate 2
Utah Geological Survey Map 213
Geologic Map of the Smoky Mountain 30'x60' Quadrangle

Geologic Map of the Smoky Mountain 30'x60' Quadrangle, Kane and San Juan Counties, Utah, and Coconino County, Arizona

by

Hellmut H. Doelling and Grant C. Willis

2006

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Salt Lake City, Utah 84114-6100

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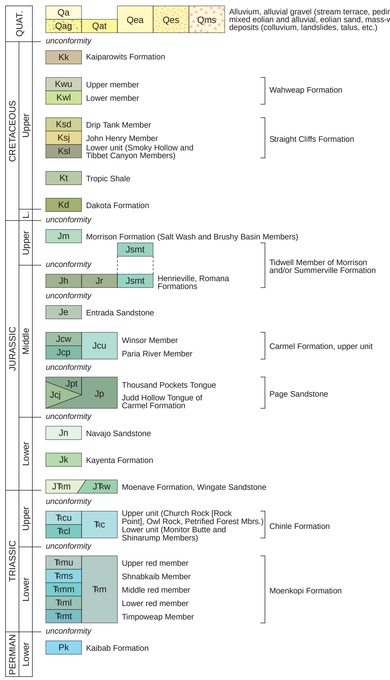
CORRELATION OF GEOLOGIC UNITS



DESCRIPTION OF GEOLOGIC UNITS

Qa **Alluvium, undifferentiated** – Gravel, sand, silt, and clay in poorly to moderately sorted and stratified deposits along most drainages; clast size and composition varies from drainage to drainage and is dependent on the nature of local bedrock; dominantly ephemeral stream deposits, but commonly includes varying amounts of debris flow deposits, eolian sand and silt, colluvium, low-level alluvial terrace deposits, alluvial-fan deposits, and floodplain deposits too small to be mapped separately at this scale; 0 to 37 meters (0-120 ft) thick.

Qes **Eolian sand deposits** – Fine- to medium-grained quartz sand and minor silt; generally overlying Jurassic sandstones (primarily Navajo and Entrada Sandstones) and locally overlying Cretaceous sandstones; form thin sheets and active dunes; 0 to 30 meters (0-100 ft) thick.

Qea **Mixed eolian and alluvial sand deposits** – Moderately to well sorted sand, silt, and lesser clay deposited by wind, locally mixed with small angular to subangular rock fragments, pebbles, and cobbles deposited as sheetwash and ephemeral wash alluvium; commonly capped by thick pedogenic carbonate (caliche), in some areas the caliche forms a resistant bench; windblown material is commonly slightly to moderately reworked by water; common on broad surfaces and covers the bedrock from which much of the material is derived; locally buries or partly buries coarser gravel deposits; includes alluvial terrace deposits (unit Qat) that are mostly covered by eolian sand; 0 to 30 meters (0-100 ft) thick.

Qat **Alluvial river terrace deposits** (Lower Pleistocene) – Moderately to well-sorted cobble to pebble gravel and sand with minor silt and clay; form terrace remnants on benches and slopes near the Colorado River; clasts were transported by the ancestral Colorado River from sources in eastern Utah and western Colorado; includes reworked terrace deposits that drape down slope from the original deposits; present about 150 m (500 ft) above the modern river bed; similar terrace deposits mostly covered by eolian sand are included in map unit Qea; mapped near Gregory Butte, but similar terrace deposits are common at several levels between the river channel and the Lake Powell high-water line and are exposed when the lake is low; 0 to 30 feet (0-9 m) thick.

Qag **Alluvial gravels, undifferentiated** – Remnants of stream terrace and pediment-mantle alluvial deposits preserved as remnants above present stream levels; similar in composition to alluvium (Qa) described above, but generally with larger percentage of bouldery clasts; composition varies dependent on local source; commonly includes eolian silt and sand and pedogenic carbonate in upper part of deposits that gradually accumulates over time such that older deposits have thicker accumulations; in general, older deposits are preserved at higher levels above current large stream valleys, but various levels have not been differentiated; probably Quaternary in age, but highest-level deposits may be Pliocene (late Tertiary) in age; 0 to 18 meters (0-60 ft) thick.

Qms **Landslides, slumps, and talus, undifferentiated** – Includes rock-fall deposits, colluvium, talus, detritus, toreva blocks, landslides, slumps, and landslide complexes; very poorly sorted, chaotic deposits ranging in composition from silt to large blocks several tens of meters in average diameter that slumped or slid downslope; upper surfaces are typically hummocky; most landslides and slumps are inactive but some show evidence of historical movement; occur in weaker rock units including the Cretaceous Wahweap Formation, Tropic Shale, and lower Straight Cliffs Formation, and Jurassic Entrada Sandstone and Carmel Formation; commonly developed on the flanks of Kaiparowits Plateau; locally include alluvial, colluvial, and eolian deposits; highly variable from 0 to 76 meters (0-250 ft) thick.

Kk **Kaiparowits Formation (Upper Cretaceous, upper Campanian to Maastrichtian)** – Moderate-gray, yellow-gray, olive-gray, brown-gray or green-gray, slope-and badlands-forming, fine-grained sandstone, thin light-gray mudstone, and light-yellow-gray calcareous siltstone; thin carbonaceous layers are common in mudstones; bedding is poorly defined and lenticular; conformable and gradational with the Wahweap below; as much as 670 meters (2200 ft) thick.

Wahweap Formation (Upper Cretaceous, Campanian)

Kwu **Upper member** – Light-gray, gray-orange, and yellow-brown, fine- to coarse-grained sandstone (mostly medium grained) interbedded with minor mudstone and sandstone; partly cross-bedded and lenticular; forms cliffs and ledges; intertongues irregularly with lower member; capped by prominent 100-meter-thick (300-ft) cliff-forming, fine- to medium-grained sandstone with rare to common pebble to cobble conglomerate near top; 46 to 240 meters (150-800 ft) thick.

Kwl **Lower member** – Yellow-gray and yellow-brown mudstone interbedded with variable amounts of fine- to medium-, and minor coarse-grained, trough cross-bedded sandstone, siltstone, and minor carbonaceous shale; mostly slope-former with local ledges; 76 to 270 meters (250-900 ft) thick.

Straight Cliffs Formation

Ksd **Drip Tank Member (Upper Cretaceous, Santonian to Lower Campanian)** – Yellow-gray and yellow-brown, fine- to medium-grained, lenticular sandstone; interlensed with minor mudstone and pebble conglomerate; iron staining and iron oxide concretions and bands common; cliff- and bench-forming unit; thins eastward; upper contact placed on a thin but prominent ledge-forming sandstone; Eaton (1991, figure 9) recommended placing the contact about 20 m (60 ft) lower on a thick ledge-forming sandstone below all major mudstone beds; 43 to 170 meters (140-550 ft) thick.

Ksj **John Henry Member (Upper Cretaceous, Coniacian to Santonian)** – Yellow-gray, slope- and ledge-forming sandstone, with interbedded mudstone, carbonaceous mudstone, and coal; contains the major coal resources of the Kaiparowits Plateau in several extensive but discontinuous coal zones; slope-forming coal zones are dominated by mudstone, carbonaceous mudstone and shale, claystone, and relatively thick coal beds up to 6 m (20 ft) or more thick; barren zones are dominated by thick-bedded to massive cliff-forming, yellowish-gray to yellowish-brown sandstones with interbeds of gray mudstone; thin friable to blocky sandstone beds, and thin limestone beds; 180 to 335 meters (590-1100 ft) thick.

Ksl **Lower unit (Combined Smoky Hollow and Tibbet Canyon Members [Upper Cretaceous, Turonian])** – Smoky Hollow Member consists of interbedded white and gray fine- to medium-grained sandstone, mudstone, carbonaceous mudstone and coal in ledge- and slope-forming beds, 7 to 71 meters (24-234 ft) thick; underlying Tibbet Canyon Member is yellow-gray to moderate brown, cliff-forming sandstone with gray mudstone and siltstone partings; cross-bedded with thin to thick bedding; fossils include pelecypods, gastropods, cephalopods, shark teeth, and trace fossils; gradational with Tropic Shale below; 21 to 56 meters (70-185 ft) thick.

Kt **Tropic Shale (Upper Cretaceous, upper Cenomanian to middle Turonian)** – Medium-gray, yellow-gray, and olive-gray fossiliferous marine mudstone and shale with subordinate gray sandstone, bentonitic claystone, siltstone, and limestone in the upper and lower parts of the formation; slope-forming unit; 150 to 230 meters (500-750 ft) thick.

Kd **Dakota Formation (Upper Cretaceous, Cenomanian, with possible upper Lower Cretaceous, Barremian to Albian)** – Interbedded gray-orange to light-brown sandstone, sandy mudstone and shale, carbonaceous mudstone, shaley sandstone, and conglomerate; and dark-brown to black carbonaceous shale and coal; upper part is sandstone with marine fossils; middle part is ledge and slope-forming sandstone, mudstone, and coal-bearing unit; lower part is a discontinuous local basal conglomerate that fills paleotopographic lows and may be at least partly Early Cretaceous in age; forms ledges and slopes; deposited unconformably across Morrison, Henrieville, Romana, and Entrada Formations; thickness varies but generally thickens westward from 1 to 46 meters (3-150 ft).

Jm **Morrison Formation (Upper Jurassic)** – Gray, yellow, and brown ledge- and cliff-forming lenticular conglomerate, conglomeratic sandstone, and sandstone, interbedded with subordinate green, gray, or purple, commonly bentonitic mudstone; present only in eastern part of quadrangle due to unconformity at base of Dakota Formation that cuts increasingly down-section to the west; outcrops are primarily Salt Wash Formation but thin slope-forming Brushy Basin Member may be present above the Salt Wash in northeast part of quadrangle; the Tidwell Member may also be present below the Salt Wash in northeast part of quadrangle (see unit Jsmt); deposited unconformably across underlying Middle Jurassic units; 0 to 210 meters (0-700 ft) thick.

Jsmt **Tidwell Member of Morrison Formation and/or Summerville Formation (Upper and/or Middle Jurassic)** – Interbedded, pale-gray to yellow-gray, pale-green-gray, and medium- to dark-red-brown, very-fine to fine-grained sandstone, siltstone, mudstone, and shale; has a few beds with very-coarse sandstone to pebbly sandstone; thin- to medium-thick planar beds form ledgy cliff to steep ledgy slope; 10 to 26 meters (35-85 ft) thick. Mapped in northeast part of quadrangle. Along the base of Fiftymile Mountain the Romana Sandstone becomes thinner and less resistant with more friable pale-gray sandstone to the northwest; Thompson and Stokes (1970) named this ledgy slope-forming strata the White Point Member of the Summerville Formation (probably a lateral equivalent of the Romana Sandstone); however, Peterson and Turner-Peterson (1987) indicated that the Romana is cut out by the J-5 unconformity and that the ledgy slope-forming beds are the Upper Jurassic Tidwell Member of the Morrison Formation; this issue has not been resolved at the time of this publication.

Jh **Henrieville Sandstone (Middle Jurassic)** – White and yellow-white unit divisible into an upper massive, cross-bedded, fine- to medium-grained eolian sandstone and a lower white and yellow-white tabular-bedded sandstone, siltstone, claystone, and shale; forms steep slopes and cliffs; exposed only along northwest margin of the Kaiparowits Plateau; likely laterally equivalent to Romana Sandstone; 0 to 71 meters (0-234 ft) thick.

Jr **Romana Sandstone (Middle Jurassic)** – Gray-yellow-green, yellow-gray, or light-tan, very fine- to fine-grained, medium-bedded to massive, planar to cross-bedded, calcareous sandstone with thin planar beds of reddish-brown, calcareous, sandy siltstone; forms massive to ledgy cliff; present only in southeastern part of quadrangle; 0 to 44 meters (0-145 ft) thick.

Je **Entrada Sandstone (Middle Jurassic)** – Mostly fine-grained sandstone; coexists of three members (not differentiated on map) based on differences in bedding, weathering characteristics, and color; lower (Gunsight Butte Member) is yellow gray in the southwest corner, and orange brown in the remainder of the quadrangle and weathers into smooth "slickrim" erosional forms and cliffs; the middle (Cannonville Member) is banded light gray and red brown along the Cockscomb, red brown elsewhere, and is friable and earthy weathering except in the southeast part near Lake Powell where it is decidedly cliff forming; the upper (Escalante Member) is present only along the north margin of the quadrangle and is mostly very light gray, smooth to earthy weathering, and displays high-angle eolian cross-beds; 90 to 290 meters (330-950 ft) thick, thickens northeastward across map area.

Carmel Formation (Middle Jurassic)

Jcu **Carmel Formation, upper unit** – Combined Paria River and Winsor Members of the Carmel as mapped in the south and east parts of the quadrangle and along The Cockscomb where too thin to differentiate at this scale; upper part (Winsor Member) mostly medium- to dark-red-brown to brown, slope-forming and earthy-weathering, silty sandstone or siltstone intercalated with sporadic irregular beds of very pale gray, calcareous, fine-grained sandstone that is locally gypsiferous; lower part (Paria River Member) is mostly dark-red-brown siltstone or silty sandstone with a few tan or brown fine-grained sandstone beds capped by silty or sandy, white to very pale red-gray, chippy-weathering limestone; upper part (Winsor Member) is 18 to 46 meters (60-150 ft) thick, lower part (Paria River Member) is 15 to 21 meters (50-70 ft) thick.

Jcw **Winsor Member** – Red-gray to yellow-gray slope-forming and earthy-weathering silty sandstone that locally includes gypsum beds; 40 to 68 meters (130-225 ft) thick where mapped in the northern part of the quadrangle; thins eastward to 18 to 46 meters (60-150 ft).

Jcp **Paria River Member** – Pale-gray to red-gray gypsum interbedded with and overlain by dark-red-brown siltstone and sandstone, with a white chippy limestone at the top; 23 to 70 meters (75-230 ft) thick where mapped in the northern part of the quadrangle; thins eastward to 15 to 21 meters (50-70 ft).

Jpt **Thousand Pockets Tongue of Page Sandstone (Middle Jurassic)** – Yellow, white, or brown, massive, cross-bedded sandstone, with common thin, red siltstone partings; forms a thick sandstone bed over the Judd Hollow Tongue in areas where the Judd Hollow is present; merges into the undivided Page Sandstone in the subsurface to the east and northeast beneath the Kaiparowits Plateau; 27 to 60 meters (90-200 ft) thick.

Jcj **Judd Hollow Tongue of Carmel Formation (Middle Jurassic)** – Interbedded red-brown sandstone, siltstone, and red and lavender limestone; composed of thin equivalents of the Crystal Creek and Co-op Creek Limestone Members of the Carmel Formation as exposed in western Kane County; present in western half of quadrangle; pinches out eastward between Thousand Pockets and Harris Wash Tongues of Page Sandstone near southwest side of Lake Powell; is present as a thin parting between sandstone tongues northeast of Fiftymile Mountain (not mapped separately); 0 to 70 meters (0-230 ft) thick.

Jp **Page Sandstone (Middle Jurassic)** – Mostly fine- to medium-grained, cross-bedded, quartzose, eolian sandstone, locally with thin dark-red basal siltstone and silty sandstone beds; unconformably overlies the similar-appearing Navajo Sandstone; mapped in the east half of the quadrangle where consists of three undifferentiated cross-bedded sandstone tongues, the Harris Wash (lower), Thousand Pockets (middle), and Lechee (upper in southeast part of quadrangle) (Blakey and others, 1983, 1996); in most of quadrangle the Judd Hollow Tongue of the Carmel Formation is between the Harris Wash and the Thousand Pockets; in areas where thick enough the Thousand Pockets and Judd Hollow are mapped separately; 10 to 76 meters (30-250 ft) thick.

Jn **Navajo Sandstone (Lower Jurassic)** – White, pale-yellow-gray, orange-gray, pale-red-brown, and brown, cross-bedded, fine- to medium-grained sandstone that forms prominent cliffs, domes, and bare-rock outcrops; characterized by massive eolian cross-bed sets; lower part has planar beds that grade upward into cross-beds; has local limestone and dolomite lenses; excellent aquifer; 290 to 520 meters (950-1700 ft) thick, generally thickening westward; in south part of quadrangle may locally include strata of the Harris Wash Tongue of the Page Sandstone.

Jk **Kayenta Formation (Lower Jurassic)** – Ledge- and slope-forming lenticular sandstone, siltstone, and mudstone with local limestone and intraformational conglomerate beds; mostly medium- to dark-red-brown, but red-orange, lavender, white, and brown sandstone is common; alluvial and floodplain depositional environment; conformable with units above and below; 58 to 104 meters (190-340 ft) thick, with no specific geographic thinning or thickening trends.

JTrm **Moenave Formation (Lower Jurassic to Upper Triassic)** – Red-orange to medium- to dark-red-brown, flat-bedded, fine-grained sandstone and siltstone; forms thin to thick ledgy cliffs and steep slopes; exposed along The Cockscomb and westward; intertongues with the Wingate Sandstone northeastward under the Kaiparowits Plateau; about 90 to 134 meters (290-440 ft) thick and locally divisible into three unmapped units, in ascending order: Wingate Sandstone-like strata near base, Dinosaur Canyon Member, and Springdale Sandstone Member; possibly unconformable with Chinle strata below.

JTrw **Wingate Sandstone (Lower Jurassic to Upper Triassic)** – Pale- to medium-red-orange to red-brown, cliff-forming, massive, fine- to medium-grained sandstone; exposed only in the Escalante River Canyon in the northeast part of the quadrangle; 60 to 90 meters (200-300 ft) thick.

Trc **Chinle Formation, undivided (Upper Triassic)**

Trcu **Upper unit (Church Rock [Rock Point], Owl Rock, and Petrified Forest Members)** – Varicolored, banded, slope forming bentonitic mudstone, claystone, sandstone, siltstone, limestone, and conglomerate that locally contains abundant petrified wood (Petrified Forest Member); grades upward into pale-reddish-gray, pale-gray, and pale-greenish-gray, muddy limestone and calcareous mudstone and very fine sandstone (Owl Rock Member); which grades upward into medium- to dark-reddish-brown, thin- to medium-bedded, ledge- to cliff-forming sandstone and siltstone (Church Rock or Rock Point Member); conducive to landsliding; 150 to 200 meters (500-650 ft) thick in areas west of The Cockscomb, but may be thicker in the subsurface to the northeast (Blakey, 1970; Doelling and Davis, 1989).

Trcl **Lower unit (Monitor Butte and Shinarump Members)** – Variegated, gray, green-gray, and brown-gray, lenticular, conglomeratic sandstone and local conglomerate, poorly to moderately sorted, fine to very coarse grained sandstone, and mudstone; Shinarump forms cliff to ledgy cliff, whereas Monitor Butte forms generally gray to greenish-gray ledgy slopes; unconformable over Moenkopi Formation; 0 to 47 meters (0-155 ft) thick along outcrops in southwest part of quadrangle; may be as much as 76 meters (250 ft) thick in the subsurface.

Trm **Moenkopi Formation, undivided (Middle? to Lower Triassic)**

Trmu **Upper red member** – Dark-brown to red-brown, very fine- to fine-grained sandstone and siltstone; upper part is thin to thick bedded and forms cliffs; lower part forms ledgy slopes; ripple marks common; about 38 meters (125 ft) thick.

Trms **Shnabkaib Member** – Light-brown, pale-red-brown, and pale-white- to yellow-gray, earthy-weathering very fine grained sandstone and siltstone with white, bedded gypsum; forms slopes with "bacon-striped" appearance; about 67 meters (220 ft) thick.

Trmm **Middle red member** – Light-red-brown, lightly banded, fine-grained, gypsiferous and earthy-weathering sandstone, siltstone, and mudstone; forms ledgy slope; about 113 meters (370 ft) thick.

Trml **Lower red member** – Red- to chocolate-brown, fine-grained sandstone and siltstone that forms slope; capped by up to about 10 meters (0-30 ft) of tan, platy to thin-bedded, ledge-forming, calcareous sandstone (Virgin Limestone Member); about 76 meters (250 ft) thick.

Trmt **Timpoweap Member** – Tan to pale-red-brown, resistant silty limestone, sandstone, siltstone, and chert breccia; forms ledges; unconformable on Kaibab Formation below; 6 to 37 meters (20-120 ft) thick.

Pk **Kaibab Formation (Lower Permian)** – Light-yellow, thick-bedded to massive, cliff-forming, fossiliferous and cherty limestone; only upper part exposed; about 50 meters (160 ft) thick in the southwestern part of the quadrangle but may locally exceed 76 meters (250 ft) in thickness; overall, thins eastward in subsurface.

Pt **Toroweap Formation (Lower Permian)** – On cross section only.

Ph **Hermit Shale (Lower Permian)** – On cross section only.

Pq **Queantoweap Sandstone (Lower Permian)** – On cross section only.

Pp/IP? **Pakoon Formation and undivided Pennsylvanian rocks? (Lower Permian to Pennsylvanian)** – On cross section only.

Mr **Redwall Limestone (Mississippian)** – On cross section only.

D **Devonian strata** – On cross section only.

C **Cambrian strata** – On cross section only.

pC **Precambrian strata** – On cross section only.

GEOLOGIC SYMBOLS

Contact; dashed where approximately located; units not shown where covered by Lake Powell

High-angle fault; dashed where approximately located or inferred; dotted where covered; bar and ball on downthrown side; arrows on cross section indicate relative direction of movement

Fault with oblique slip; dashed where approximately located or inferred; dotted where covered; bar and ball on downthrown side

High-angle reverse fault on cross section

Folds - Fold axes not dotted across surficial deposits though these deposits are not folded

Anticlinal fold axis; arrow paralleling axis shows direction of plunge

Synclinal fold axis; arrow paralleling axis shows direction of plunge

Monoclinal fold axis; placed near top of upper fold axis

1800 Structure contours drawn at base of Dakota Formation; dashed where projected above ground surface; contour interval 100 meters

Oil and/or gas test well location - oil show

Oil and/or gas test well location - dry hole

Natural arch

Mine

A — A' Line of cross section

Southern part of the Kaiparowits Plateau near Glen Canyon City west of Lake Powell's Wahweap Bay. *(photo by Doug Sprinkel)*

Mesa between Dominguez and Boundary Buttes on the south side of Padre Bay. *(photo by Doug Sprinkel)*

LITHOLOGIC COLUMN

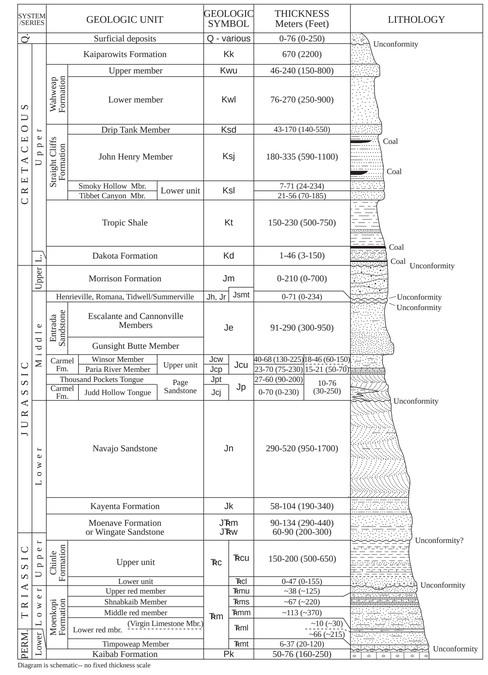
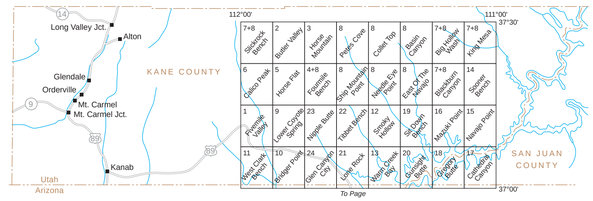


Diagram is schematic-- no fixed thickness scale



SOURCE LIST FOR GEOLOGIC MAPPING

(Numbers correspond to those on index map.)

This map was compiled primarily from the 1:100,000-scale geologic map of Kane County (Doelling and Davis, 1989). The area southeast of Lake Powell was compiled from large-scale maps of this area (see map above). Hellmut Doelling compiled the Kane County map from sources shown on the index map and made minor to extensive modification based on field mapping during 1985-89. Doelling and Grant Willis made additional modifications based on field mapping in 1996 and 2005.

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13. —1973, Geologic map of the southwest quarter of the Gunsight Butte [Warm Creek Bay] quadrangle, Kane and San Juan Counties, Utah, and Coconino County, Arizona: U.S. Geological Survey Map MF-306, scale 1:24,000.
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