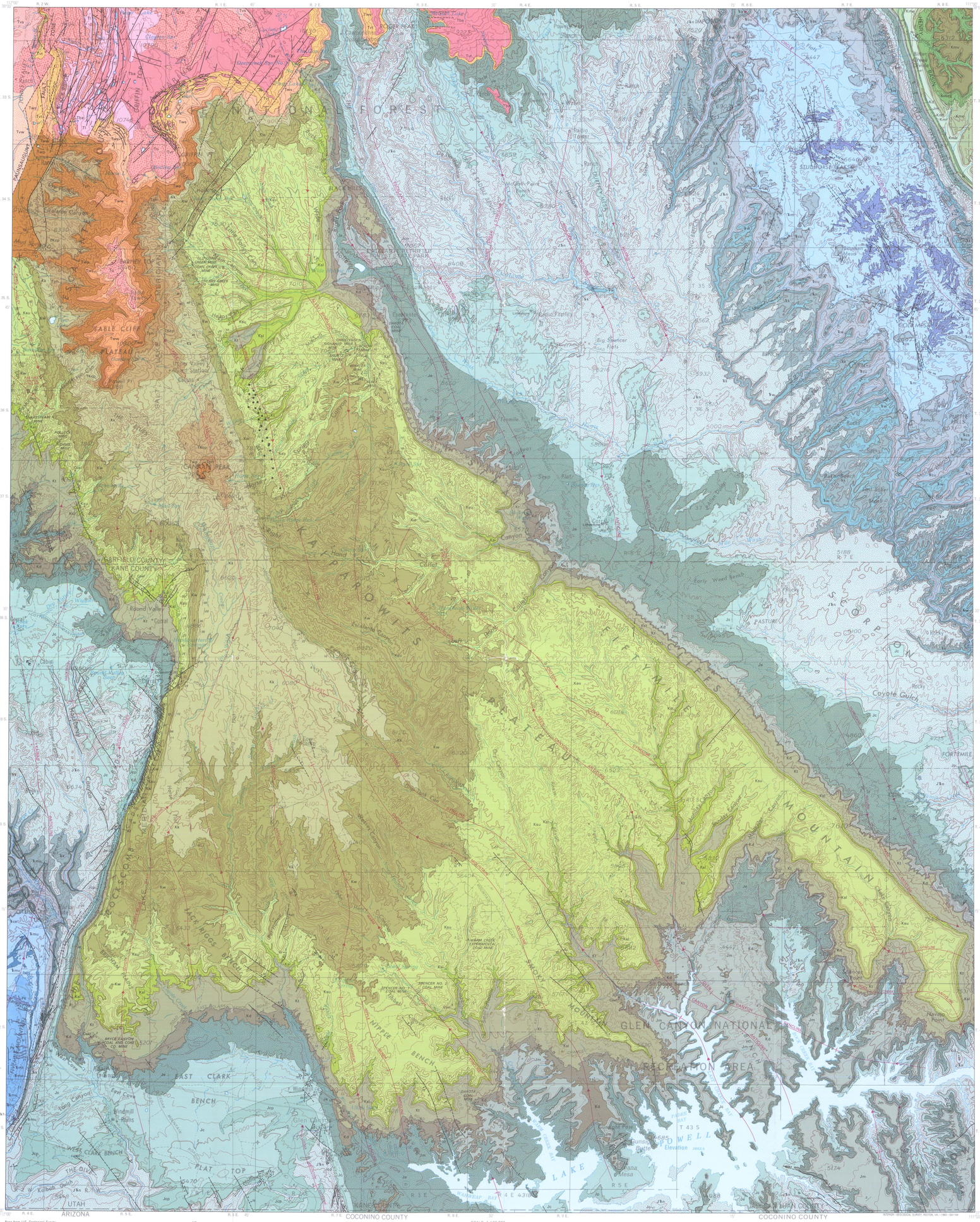


Base from U.S. Geological Survey, Escalante, 1956–70, scale 1:250,000

Geology compiled in 1976–1980

SCALE 1:125 000

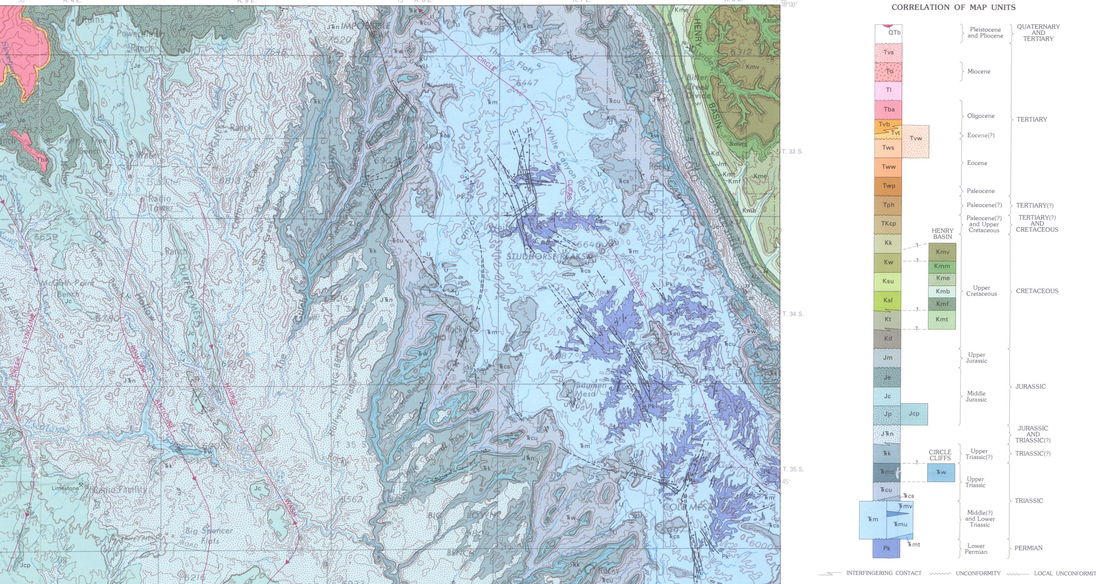
CONTOUR INTERVAL 200 FEET
WITH SUPPLEMENTARY CONTOURS AT 100 FOOT INTERVALS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

BEDROCK GEOLOGIC MAP OF THE KAIPAROWITS COAL-BASIN AREA, UTAH

Compiled by
K. A. Sargent and Dan E. Hansen

1982

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

QTb BASALT (PLEISTOCENE AND PLIOCENE)—Dark-gray olivine-clinopyroxene-labradorite basalt in thin flows; commonly weathers to blocks. Less than 200 ft (61 m) thick on Aquarius Plateau

Tvs VOLCANICLASTIC SEDIMENTS (TERTIARY)—Conglomerate, sandstone, and siltstone composed mostly of volcanic material; poorly exposed. Thickness 0 to 200 ft (0–61 m)

Tc OSIRIS TUFF (MIOCENE)—Gray, purplish-gray, and red-brown latitic ash-flow tuff. Densely welded, crystal rich; 20–25 percent phenocrysts of andesine, sanidine, minor quartz, clinopyroxene, and biotite. Weathers to rounded boulders. Thickness 0 to 600 ft (0–183 m). Early to middle Miocene age, 22.1 ± 0.4 to 22.8 ± 0.4 m.y. (Fleck and others, 1975)

Tl LATITE (TERTIARY)—Dark-gray to purplish-gray, aphyric to sparsely porphyritic lava flows and minor welded ash-flow tuffs. Commonly contains 5–10 percent phenocrysts of andesine, sanidine, and clinopyroxene. Thickness 0 to about 600 feet (0–183 m)

Tba BASALTIC ANDESITE (OLIGOCENE)—Dark-gray, dark-brown, and dark-red, dense to vesicular, crystal-rich, massive flows and flow breccias. Contains large distinctive green augite and equant labradorite, and less common olivine phenocrysts. Thickness 0 to 700 ft (0–213 m)

Tvb ANDESITE BRECCIA (OLIGOCENE)—Gray, pink, or pale-green, thick-bedded mudflow breccias; clasts contain large green hornblende crystals. Thickness 0 to 15 ft (0–4.6 m). Grades laterally southward into tuffaceous sediments within a mile of the north edge of the map, along East Fork Sevier River. In part equivalent to Bullion Canyon Volcanics of Manynote area

Tvt TUFFACEOUS SEDIMENTS (OLIGOCENE AND EOCENE?)—White, pale-brown, and red tuffaceous siltstone, shale, arkosic sandstone, and pebble conglomerate in thin-and-even to thick-and-lenticular beds. Local silicified zones yield dense red, orange, yellow, and white chalcedony. Exposed in cliffs capped by massive latite or basaltic andesite. Thickness 0 to about 600 ft (0–183 m)

Tws WASATCH FORMATION, VARIEGATED SANDSTONE MEMBER (EOCENE)—Pink to red sandstone, siltstone, mudstone, and limy mudstone; soft; interbedded with white to gray, fine- to coarse-grained sandstone; 10- to 30-foot-thick (3- to 9-meter-thick) basal conglomerate contains well-rounded black chert, light quartzite, and gray limestone. Thickness 0 to 600 ft (0–183 m). Thickest exposures west of Griffin Top. Pinches out to east near Roger Peak

Tww WASATCH FORMATION, WHITE LIMESTONE MEMBER (EOCENE)—White to light-gray limestone; very finely crystalline to microcrystalline; contains thin yellowish-gray mudstone interbeds mostly in middle and lower parts; some beds contain early to middle Eocene fresh-water gastropods. Thickness 0 to about 600 ft (0–183 m). Pinches out to east in upper part of North Creek drainage

Twp WASATCH FORMATION, PINK LIMESTONE MEMBER (EOCENE AND PALEOCENE)—Pink, pale-orange, light-gray, and white limestone; commonly mottled pink or yellow; irregularly bedded to massive, very fine grained to fine grained, clastic; contains thin gray to red limy mudstone interbeds, locally contains lenticular fine- to coarse-grained calcareous sandstone or calcarenite and thin (1–6 ft; 0.3–2 m) dark-gray microcrystalline limestone beds that contain dark shell fragments; overall pink color of member produced by stain from interbedded red units. Thickness 0 to 900 ft (0–274 m). Forms pink cliffs, columns, and spires, or steep forested slopes

Twv OLIGOCENE AND EOCENE? TUFFACEOUS SEDIMENTS AND EOCENE VARIEGATED SANDSTONE MEMBER OF THE WASATCH FORMATION, UNDIVIDED

Tph PINE HOLLOW FORMATION (PALEOCENE?)—Red and gray calcareous mudstone and bentonitic claystone; gray limy sandstone and pebbly sandstone layers near base; poorly exposed, forms gentle slopes. Thickness 0 to 450 ft (0–137 m)

TKcp CANAAN PEAK FORMATION (PALEOCENE? AND UPPER CRETACEOUS)—Light-gray, pink, or brown sandstone, conglomeratic sandstone, and conglomerate; contains multicolored well-rounded pebbles, cobbles, and small boulders of quartzite, chert, aphyric to porphyritic silicic igneous rocks, and some gray limestone; boulders locally exceed 12 inches in diameter. Lower part includes mudstone interbeds containing Late Cretaceous (Campanian) pollen and spores. Thickness 0 to about 1000 ft (0–305 m)

Kk KAIPAROWITS FORMATION (UPPER CRETACEOUS)—Predominantly grayish-green to olive-green and biotitic silty sandstone; fissile, lenticular; contains some thin interbeds of light-gray mudstone, lenticular pelletal gray limestone, and brown resistant sandstone; dinosaur bones, turtle shells, and fresh-water molluscs common in some beds; upper part yielded Late Cretaceous (Campanian) pollen and spores (Bowers, 1972); continental; weathers to badland topography in The Blues, where formation is thickest; less than 500 to 3,000 ft (91–914 m) thick; generally erodes to gentle slopes. Base conformable and gradational with Wahweap Formation

Kw WAHWEAP FORMATION (UPPER CRETACEOUS)—Interbedded sandstone, siltstone, mudstone, and shale; grades from chiefly mudstone near base to massive cliff-forming sandstone at top. Mudstone, shale, and siltstone, gray to olive-green, sandy, form slopes. Sandstone, light-yellow to brownish-orange, fine- to medium-grained, flat- and cross-stratified, in lenticular beds, forms cliffs. Upper 300 ft (91 m) contains persistent pebble-conglomerate and conglomeratic sandstone lenses as much as 3 ft (0.9 m) thick; thin gray shale interbeds in upper 100 ft (30 m). Base is conformable on Straight Cliffs Formation. Thickness 900 to 1,550 ft (274–472 m)

Ksu STRAIGHT CLIFFS FORMATION, UPPER PART (UPPER CRETACEOUS)—Includes Drip Tank and John Henry Members, 1000 to 1700 ft (305–518 m) thick, undivided

Drip Tank Member—Light-gray to white sandstone, medium- to coarse-grained, locally conglomeratic, massive, crossbedded, cliff-forming; locally may contain some carbonaceous mudstone. Fluvial, but base may be reworked marine or beach sand. Thickness 200 to 400 ft (61–122 m)

John Henry Member—Sandstone, mudstone, carbonaceous mudstone, and coal. Sandstone is light gray to light brown, very fine grained to coarse grained and cross bedded. Mudstone is olive gray to light brown. Carbonaceous mudstone is dark gray to black. Contains the major coal resources of the Kaiparowits Plateau. In ascending order the coal zones are: lower, Henderson or Christensen, Rees, and Alvey (Hansen, 1978). Massive sandstone bed in lower part contains pebble conglomerate lenses and fragments of *Inoceramus* shells. Base is a thin pebble conglomerate unconformable on Smoky Hollow Member. Rocks are marginal marine to lagoonal and paludal deposits. Thickness 660 to 1300 ft (201–396 m)

Ksl STRAIGHT CLIFFS FORMATION, LOWER PART (UPPER CRETACEOUS)—Includes Smoky Hollow and Tibbet Canyon Members, 140 to 485 ft (43–148 m) thick, undivided

Smoky Hollow Member—Light-gray to light-brown sandstone, fine- to coarse-grained, thin-bedded to massive, locally conglomeratic; contains mudstone or carbonaceous mudstone and thin coal beds in upper and lower parts. Lower part interfingers with upper part of Tibbet Canyon Member. Thickness 20 to 300 ft (6–91 m)

Tibbet Canyon Member—Yellowish-gray to grayish-orange sandstone; middle and upper parts are fine to medium grained, moderately well sorted, thin to thick bedded, thinly to thickly crossbedded; interbedded with minor siltstone and mudstone. Rocks are marginal marine and beach deposits. Lower contact gradational, intertongues with Tropic Shale; contact placed at base of lowest persistent sandstone. Thickness 62 to 185 ft (19–56 m)

Kt TROPIC SHALE (UPPER CRETACEOUS)—Medium- to dark-olive-gray calcareous marine shale; thin yellowish-gray to light-brown, fine-grained sandstone and siltstone interbeds in upper part. Thin white bentonite beds common in lower 50 ft (15 m), but uncommon above. Widespread layer of light-gray fossiliferous marine limestone concretions (*Scipionoceras zone*) 12 to 30 ft (4–9 m) above base. Numerous selenite crystals on lower slopes. Thickness 600 to 900 ft (183–274 m)

Kmv MESAVERDE FORMATION (UPPER CRETACEOUS)—Yellowish-gray, fine-grained to conglomeratic sandstone and scarce thin interbeds of gray shale; forms cliffs. Includes slope-forming interbedded gray mudstone and lesser quantities of brown sandstone at top informally named the beds on Tarantula Mesa (Peterson and Ryder, 1975). Occurs only in northeast corner of map area. Uppermost part possibly equivalent to Kaiparowits Formation. Eroded to less than 400 ft (122 m) thick

Kmm MANCOS SHALE (UPPER CRETACEOUS)—Nearshore continental and marine beds totaling about 3400 ft (1036 m) thick. Divided into 5 members. Mapped only east of Waterpocket Fold in northeast part of map area

Masuk Member—Dark-gray silty mudstone, carbonaceous shale, and light-yellow sandstone. Lowermost part contains fossil shark teeth and marine shells. Forms steep smooth slope where capped by Mesaverde Formation. Thickness 700 to 900 ft (213–274 m)

Kme Emery Sandstone Member—In non-marine upper part, pale-gray to white lenticular crossbedded sandstone, mudstone, carbonaceous shale, and coal; contains the major coal resources of the Henry basin. In lower part, yellowish-gray, fine-grained, massive, cliff-forming, evenly thick bedded marine sandstone. Thickness 120 to 300 ft (37–91 m)

Kmb Blue Gate Member—Dark-bluish-gray marine shale, with some thin beds of pale-gray to yellow-brown bentonite, shaly sandstone, and sandy limestone. Unconformably overlies the Ferron Sandstone Member. Thickness 1200 to 1500 ft (366–457 m)

Kmf Ferron Sandstone Member—Yellowish-brown to white lenticular fine-grained sandstone, gray marine mudstone, and, in upper part, carbonaceous shale and some coal. Sandstone is ripple laminated to even bedded and crossbedded. Thickness 200 to 350 ft (61–107 m)

Kmt Tununk Member—Dark-gray marine mudstone and shale, with some to many thin bentonite beds. Weathers to form slopes. Beds at base of unit contain abundant fossil oysters, and *Gryphaea neuberryi* Stanton. Contact with underlying Dakota Sandstone is gradational. Thickness 500 to 650 ft (168–198 m)

Kd DAKOTA SANDSTONE (UPPER CRETACEOUS)—Moderate-grayish-orange sandstone, interbedded shale, siltstone, coal, and carbonaceous shale. Sandstone is lenticular, cliff forming, fluvial to littoral, crossbedded, and coarse grained; mudstone is yellowish-gray to olive, and forms slopes; carbonaceous shale is dark gray to brown; coal beds, which may be present in about middle of unit, are generally thin, lenticular, and impure, grading laterally to carbonaceous shale. Uppermost sandstone beds contain abundant molluscs *Ostrea* and *Exogyra*. Locally contains a basal quartz-, quartzite-, and chert-pebble conglomerate. Formation rests on an unconformity that bevels successively older formations from northeast to southwest. Thickness 15 to 350 ft (5–107 m). Width of outcrop band on map locally exaggerated to show continuity

Jm MORRISON FORMATION (UPPER JURASSIC)—Variegated continental beds of sandstone, conglomeratic sandstone, and bentonitic mudstone; 740 ft (226 m) thick in northeast, thins southwestward by erosional truncation to a wedge edge. Formation consists of four members (not mapped separately in this report)

Upper member and Brushy Basin Member—Upper member is interbedded, light-gray, fine- to medium-grained sandstone and grayish-yellow-green to dark-reddish-brown mudstone. Locally at top, the member has as much as 57 ft (17 m) of conglomerate and pebbly sandstone that contains petrified logs. Lower contact fairly sharp but interfingering. Rocks are alluvial-plain and lacustrine deposits. Upper member occurs south and southeast of Collet Canyon. Thickness 0 to 364 ft (0–111 m). Brushy Basin Member light to dark gray, pale green, red brown, and purple bentonitic mudstone, and sparse lenses of multicolored chert-pebble conglomerate commonly containing silicified plant and vertebrate remains. Forms gentle slopes. Brushy Basin Member occurs in the Waterpocket Fold area and near Escalante. Thickness 0 to about 250 ft (0–76 m). It is lateral equivalent to the upper member. In northermost Waterpocket Fold area the top part of unit mapped as Brushy Basin Member may include as much as 58 ft (18 m) of the upper member of the Cedar Mountain Formation of Early Cretaceous age (Hackman and Wyant, 1973, and Craig 1959, sec. 189); however, Peterson and Ryder (1975) report that the Cedar Mountain is probably not present south of Notom along the Waterpocket Fold

Salt Wash Member—Light-yellowish-gray to grayish-green, fine- to medium-grained sandstone. Contains scattered conglomerate lenses and several beds of grayish-yellow-green and dark-reddish-brown mudstone. Unit forms cliffs. Thickness 0 to 340 ft (0–104 m)

Lower member—Also called Tidwell unit by some workers and lower part has been called Summerville Formation by some authors for central and northern Kaiparowits Plateau area and along the Waterpocket Fold. Light-gray, laminated to thin-bedded, fine-grained sandstone, and interbedded greenish-gray and reddish-brown shale and mudstone; locally, contains thin gray dense limestone lenses 1 to 2 ft (0.3–0.6 m) thick. Lower contact sharp; regional studies by Peterson (1980) indicate it is an unconformity. Thickness 0 to 200 ft (0–61 m)

Je SANDSTONE AT ROMANA MESA AND ENTRADA SANDSTONE (MIDDLE JURASSIC)

Sandstone at Romana Mesa—Grayish-yellow-green to yellowish-gray sandstone; fine grained, thin to thick bedded and very thickly crossbedded; small-granule conglomerate lenses rare; flat-bedded siltstone common in lower part. Basal 0 to 6 ft (0–2 m) is hard consisting of siltstone and silty mudstone that is moderate reddish brown and laminated to thin bedded; lower contact sharp and parallel to bedding, regional studies by Pipiringos and O'Sullivan (1978, p. A23) identify this contact as the J–3 unconformity. Rocks are nearshore marine, beach, and eolian deposits. Forms cliffs. Correlates with Summerville Formation of central Utah. Beveled by Morrison Formation in eastern part of map area. Pinches out to northwest on Fiftymile Mountain near Sunset Flat (Fred Peterson, written commun., 1980). Thickness 0 to 145 ft (0–45 m)

Entrada Sandstone—Generally composed of three intergrading informal units of subequal thickness. Total thickness is more than 1000 ft (305 m) in northwestern part of map area, thinning radially westward, southward, and eastward to 400 ft (122 m) or less. In south central part of map area unit includes what some authors called Cow Spring Sandstone; regional stratigraphic studies by Fred Peterson, 1974 (Peterson, oral commun., 1980) indicate that the Cow Springs is a thick bleached zone in the upper part of the Entrada Sandstone

Upper member—Pale-gray, yellowish-gray, and reddish-brown, fine- to coarse-grained, eolian sandstone; thickly cross-bedded in high-angle sets bounded by flat-truncation planes; cliff former. Thickness 0 to 300 ft (0–91 m)

Middle member—Alternating thick sets of pale-to moderate-reddish-brown silty sandstone and dusky-red siltstone beds. Includes minor dark-reddish-brown mudstone and scarce very thin beds of grayish-purple bentonite; generally forms red and white banded cliff. Rocks are probably shallow marine, sabkha, and eolian deposits. Slope former. Thickness 70 to 310 ft (21–94 m)

Lower member—Reddish-brown to pale-gray, very fine-grained, thinly to thickly crossbedded sandstone. Commonly slumped at base into underlying Carmel Formation. Forms smooth cliffs with rounded shoulders at top and isolated buttes. Rocks are probably eolian and sabkha deposits. Thickness 360 to 650 ft (116–198 m)

Jc CARMEL FORMATION (MIDDLE JURASSIC)—Mottled reddish-brown to greenish-gray limy siltstone, fine-grained friable sandstone, claystone, yellowish-gray to pink limestone, and thin to thick beds of gypsum. Limestone is thin bedded and crinkly. Forms ledgy slopes. Rocks are marginal marine and sabkha deposits. Limestone and gypsum content increases westward, as does thickness (from about 110 ft (34 m) to more than 900 ft (274 m)). Map unit locally includes Judd Hollow Tongue of the Carmel and Page Sandstone

Judd Hollow Tongue—Moderate-reddish-brown calcareous sandstone, siltstone, and mudstone. Thins eastward; pinches out east of the town of Glen Canyon. Farther north the unit pinches out to southeast between Twentyfive Mile Wash and Early Weed Bench (Peterson and Pipiringos, 1979). Unit grades laterally westward into a limestone member of the Carmel Formation. Thickness 0 to 110 ft (0–34 m)

Jp PAGE SANDSTONE (MIDDLE JURASSIC)—Moderate-reddish-orange to moderate-reddish-brown, fine-grained, very thickly crossbedded eolian sandstone; in most localities contains small angular chert pebbles at base; forms cliffs; lower contact sharp and unconformable. Thickness 0 to 252 ft (0–77 m). Rocks now assigned to the Page were considered part of the Navajo Sandstone by previous workers; however, work by Pipiringos and O'Sullivan (1978) shows they are separated by a regional erosion surface termed the *J–2* unconformity. Progressing northwestward from the type section near Page, Arizona, the Page Sandstone is split into two tongues by the southeastward-thinning Judd Hollow Tongue of the Carmel Formation. The upper tongue of the Page is called the Thousand Pockets Tongue and the lower is called the Harris Wash Tongue. The Page Sandstone is shown locally where known and where thick enough to show at map scale

Thousand Pockets Tongue—White to light-gray to moderate reddish-brown, fine- to medium-grained, massive, crossbedded, well sorted, cliff-forming sandstone; includes pale-reddish-brown calcareous siltstone 10 ft (3 m) thick near middle. Thickness 0 to 252 ft (0–77 m). Thickest at East Cove, in the southwest corner of map area (Phoenix, 1963) thinning to north, and pinching out near Cannonville, Utah 3 miles (4.8 km) west of map border

Harris Wash Tongue—Very light gray to grayish-red, very fine grained to fine grained, well-sorted, crossbedded sandstone; in most localities contains small angular chert pebbles at base. Thickness 0 to 120 ft (0–37 m). Probably absent west of a line from the Cockscomb to Wide Hollow Reservoir, a few miles west of the town of Escalante (Peterson and Pipiringos, 1979)

Jcp JUDD HOLLOW TONGUE OF THE CARMEL FORMATION AND PAGE SANDSTONE, UNDIVIDED (MIDDLE JURASSIC)—About 130 to 297 ft (40–91 m) thick

JTRn NAVAJO SANDSTONE (JURASSIC AND TRIASSIC?)—White, light-gray, and yellowish-gray, locally reddish-orange, thickly crossbedded, medium- to fine-grained eolian sandstone; contains a few lenses less than 10 ft (3 m) thick of dark-gray partly chertified magnesian limestone. Erodes to massive cliffs and domes. Contact with underlying Kayenta Formation is sharp to gradational, and locally interfingering. Adjacent to Lake Powell the map unit locally includes Page Sandstone. Thickness 950 to 1,800 ft (290–549 m)

TRk KAYENTA FORMATION (UPPER TRIASSIC?)—Reddish-brown, dark-purplish-red, grayish-white, greenish-gray, and lavender fluvial sandstone, orange to pink siltstone, red shale, and minor shale-pellet conglomerate, and fresh-water limestone. Sandstone beds are lenticular, horizontally stratified to cross stratified, in thin to thick low-angle trough and planar sets. Erodes to cliffs and benches. Interfingers with overlying and underlying formations. Thickness 250 to 400 ft (76–122 m)

TRwo MOENAVE FORMATION (UPPER TRIASSIC)—Includes Springdale Sandstone Member and Dinosaur Canyon Sandstone Member. The Moenave is thickest in the southwest corner of the map area near Paria, where it conformably overlies about 60 ft (18 m) of Wingate Sandstone (Wingate mapped with Moenave in Paria area). Moenave thins to the northeast and is not present in the Circle Cliffs

Springdale Sandstone Member—Pale-red to light-brown, fine- to very fine-grained micaceous sandstone and minor claystone and siltstone pellet conglomerate. Sandstone occurs in large overlapping or partly overlapping lenticular beds in low- to very low-angle cross-laminae that are separated by erosion surfaces and interbedded with thin lenses of claystone and siltstone conglomerate. Forms cliffs. Thickness 0 to about 220 ft (0–67 m)

Dinosaur Canyon Sandstone Member—Reddish-orange to reddish-brown, very fine-grained to medium-grained, poorly sorted sandstone, siltstone, and mudstone. The sandstones are generally 1 to 8 ft (0.3–2.4 m) thick with low-angle cross laminations to parallel bedding. Mudstones are red, fissile, and slightly micaceous. Unit forms ledges and slopes. Thickness 0 to about 150 ft (0–46 m)

TRw WINGATE SANDSTONE (UPPER TRIASSIC)—Light-brownish-orange, reddish-brown, light-brown, fine-grained eolian sandstone. Altered to white throughout an irregular area in the northwest part of the Circle Cliffs. Generally very well sorted, calcareous and thickly crossbedded. Uppermost 100 ft (30 m) contains discontinuous thin beds of red siltstone and gray carbonate rock along parting planes. Erodes to vertical cliffs commonly coated with dusky-red desert varnish. Thickness 0 to about 60 ft (0–18 m) in Paria area, to about 350 ft (107 m) in the Circle Cliffs. Wingate is separated from the underlying Chinle Formation by an unconformity

TRcu CHINLE FORMATION (UPPER TRIASSIC)—Varicolored beds of fluvial and lacustrine origin, generally sandy at top; calcareous, argillaceous, and bentonitic in the middle; and sandy and conglomeratic near base

Upper part—Includes Church Rock, Owl Rock, Petrified Forest, and Monitor Butte Members. Thickness 400 to 1000 ft (122–305 m)

Church Rock Member—Brown, fine- to medium-grained sandstone. Massive, cross stratified on a small scale. Deposited in lakes and by streams on an alluvial plain. Discontinuously present in southeastern Circle Cliffs. Thickness 0 to 25 ft (0–8 m)

Owl Rock Member—Resistant thin lenticular beds of green limestone interbedded with red, brown, and greenish-gray sandstone and mudstone. Moderately bentonitic. Locally has a few conglomerate beds that contain limestone, siltstone, and chert pebbles. Rocks are lacustrine and fluvial deposits. Thickness 100 to 250 ft (30–76 m)

Petrified Forest Member—Purple, red, yellow, and greenish-gray bentonitic mudstone, muddy sandstone, and minor conglomerate. Mudstone is very silty, bentonitic, firmly cemented, and calcareous; locally contains limestone nodules. Sandstone beds contain silicified logs locally, some as much as 3 ft (0.9 m) in diameter and 40 ft (12 m) in length, and fragments of broken logs. Thickness 150 to about 520 ft (46–158 m)

Monitor Butte Member—Greenish-gray, dark-reddish-brown, and grayish-blue bentonitic mudstone containing lenses of gray sandstone and brown conglomerate. Thin lenticular beds of conglomerate are common, and contain light-brown limestone cobbles and pebbles, and some charcoaly and silicified wood fragments in a sandstone matrix. Thickness 100 to 200 ft (30–61 m)

TRck Shinarump Member and mottled-siltstone unit, undivided

Shinarump Member—Gray to yellowish-white sandstone with subordinate lenses of clayey siltstone, grayish-green shale, and pebble or cobble conglomerate. Contains quartz pebbles, carbonized plant debris, and fragmental silicified wood. Forms overhanging cliffs where thick; where thin, forms rounded buttes and ledges. Locally contains uranium and vanadium deposits. Thickness 0 to 200 ft (0–61 m)

Mottled-siltstone unit—Reddish-brown, mottled white siltstone and local muddy conglomeratic sandstone lenses. Forms ledges. Thickness 0 to 50 ft (0–15 m) in Circle Cliffs area

TRm MOENKOPI FORMATION (MIDDLE? AND LOWER TRIASSIC)

Moenkopi Formation—Mapped in Circle Cliffs area; fine-grained red beds and thin marine limestone and evaporite tongues. Consists of the following five members

Upper ledge-forming member—Mudstone, sandstone, dolomitic sandstone, and minor dolomite. Forms cliffs. Mudstones are dark reddish brown. Sandstones are greenish gray to yellowish gray, and very fine grained, thin bedded, dolomitic, and silty. Rocks are shallow water marine deposits. About 45 ft (14 m) thick, but may be cut out by channels of Shinarump Member of Chinle Formation

Slope-forming member—Reddish-brown siltstone or mudstone. Contains a few thin, very fine grained, brown to light-green to gray sandstone beds. Forms smooth slope. The lower 40 to 50 ft (12–15 m) is locally asphaltic and weathers light yellow. Rocks are shallow water marine deposits. Thickness about 250 ft (76 m)

Ledge-forming member—Brownish-red, grayish-red, and light-gray interlayered sandstone and siltstone. Ripple marks and small-scale crossbedding common. Rocks are near shore or lagoonal deposits. May have some oil or asphalt impregnation. Thickness 200 to 245 ft (61–75 m)

Sinbad Limestone Member (Lower Triassic)—Brownish-orange to yellow-orange conglomeratic dolomitic sandstone grading westward to dolomite. Locally crossbedded. Oolitic textures, gastropod coquina, and fossil fragments are common. Member is probably correlative with part of the Timpoweap Member mapped in the southwestern part of the area. Thickness 0 to 120 ft (0–37 m)

Basal member—White to light-gray fine-grained dolomitic sandstone to sandy dolomite. Contains abundant fragments of gray chert; locally as much as 50 percent bedded chert. Exposed mainly as rubble or chert fragments capping benches and ledges of Kaibab Limestone. Both a fluvial and a residual deposit. Thickness 15 to 25 ft (5–8 m)

TRmu Moenkopi Formation, main body—Mapped in southwestern part of map area. Consists of four members, undivided: upper red member, Shnabkaib Member, middle red member, and lower red member

Upper red member—Deep-reddish-brown silty shale and siltstone, and thick beds of brown, fine-grained, calcareous sandstone. Minor bedded and cross-cutting gypsum. Ripple marked in lower part. About 100 ft (30 m) thick

Shnabkaib Member (Lower Triassic)—Pale-reddish-brown mudstone and siltstone intercalated with light-bluish-gray gypsum and mudstone. About 164 ft (50 m) thick

Middle red member—Reddish-brown shaly mudstone and siltstone with interbedded poorly sorted micaceous sandstone and thin beds of blue-green mudstone and bedded gypsum. Ripple marks common. About 340 ft (104 m) thick

Lower red member—Light-reddish-brown micaceous silty shale, with interbedded sandstone and ripple-marked siltstone. Bedded and cross-cutting gypsum common. About 140 ft (43 m) thick

TRtu Virgin Limestone Member (Lower Triassic)—Mappec in southwestern part of map area; thin- to medium-bedded, yellow, sandy limestone, and blue-gray, micaceous siltstone. Wavy to lenticular bedding. Forms hogbacks and mesa caps. About 12 ft (4 m) thick

TRmt Timpoweap Member (Lower Triassic)—Mapped in southwestern part of map area; buff to deep-yellow, flaggy limestone and dolomitic limestone; contains yellow-brown chert and limestone-pebble conglomerate at base. Limestone is cross laminated. Member contains very poorly preserved gastropods. Thickness 20 to 50 ft (6–15 m) thick

Pk KAIBAB LIMESTONE (LOWER PERMIAN)—Grayish-yellow, fossiliferous, cherty, thin- to thick-bedded dolomitic limestone and interbedded light-gray to brown siltstone and sandstone. Fossils include brachiopods, bryozoans, pelecypods, and crinoid columnals. About 120 ft (37 m) exposed in Sand Gulch in southwest corner of map area. Thickness 45 to 60 ft (14–18 m) in Circle Cliffs area. In Circle Cliffs area map unit includes White Rim Sandstone Member of the Cutler Formation, a light-gray dolomitic sandstone with some interbedded light-brown dolomite, about 150 ft (46 m) thick

CONTACT—Dashed where approximately located or concealed

FAULT—Showing dip. Dashed where approximately located, inferred, or concealed. Bar and ball on downthrown side. Arcuate faults at the head of North Creek, east of Griffin Top, indicate the upper edge of slump and toreva blocks that moved down across less competent tuffaceous sedimentary rocks and sandstone as coherent masses. Many blocks and fault slivers west of Griffin Top may have moved or rotated downhill partly by gravity sliding; however, the major displacement is due to tectonic offset along the Paunsaugunt Fault zone

ANTICLINE—Showing trace of axial plane and plunge. Dashed where approximately located or concealed

SYNCLINE—Showing trace of axial plane and plunge. Dashed where approximately located or concealed

STRIKE AND DIP OF BEDS
Inclined
Horizontal

STRIKE AND DIP OF FOLIATION
Inclined
Horizontal

LANDSLIDE OR GRAVITY SLIDE BLOCK—Dashed where approximately located or concealed

WELLS
Dry hole or abandoned oil well
Oil well
Water well

SHAFT—For copper

QUARRY—For limestone, gypsum, or gravel, as indicated

PROSPECT—For uranium (U), titanium (Ti), copper (Cu), or coal; queried where commodity is uncertain

ADIT—For uranium (U), copper (Cu), or coal

INACCESSIBLE ADIT—For coal

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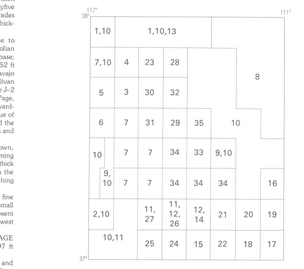

INDEX SHOWING SOURCES OF GEOLOGIC DATA

GEOLOGIC SOURCES

Geology from these published and unpublished maps has been modified and adjusted to fit the topographic base. Locally, geologic contacts may have been added photogrammetrically for continuity, and other contacts may have been dropped.

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