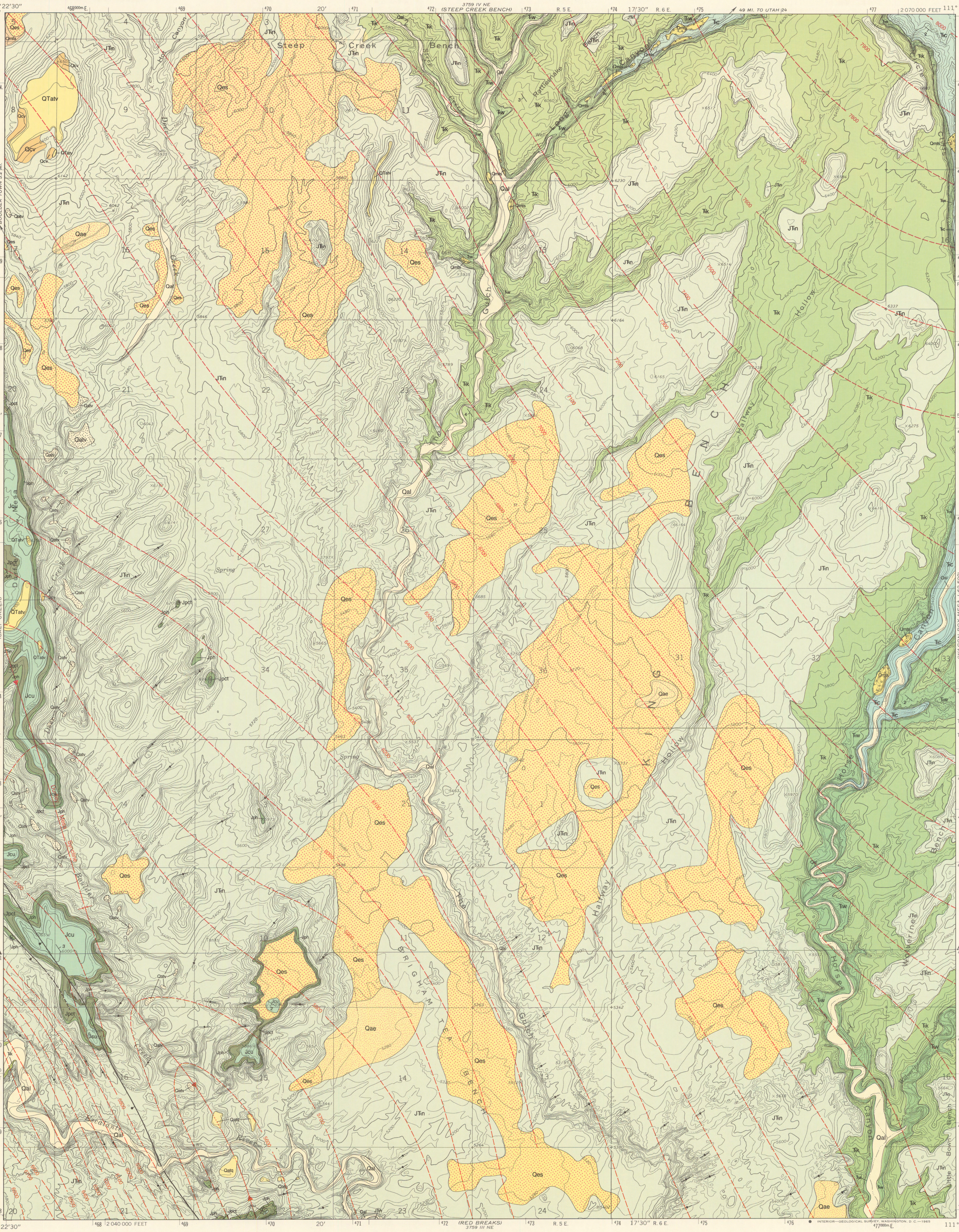
UTAH GEOLOGICAL AND MINERAL SURVEY
UTAH DEPARTMENT OF NATURAL RESOURCES
in cooperation with
THE UNITED STATES GEOLOGICAL SURVEY



Base map from U.S. Geological Survey,
King Bench Quadrangle 1964

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET
DATUM IS MEAN SEA LEVEL

UTM GRID AND 1969 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

QUADRANGLE LOCATION

Field mapping by authors in 1980 and 1987
Kent D. Brown, Cartographer

GEOLOGIC MAP OF THE KING BENCH QUADRANGLE, GARFIELD COUNTY, UTAH

by
Gordon W. Weir and L. Sue Beard
U.S. Geological Survey

1990

UTAH GEOLOGICAL AND MINERAL SURVEY
UTAH DEPARTMENT OF NATURAL RESOURCES
in cooperation with
THE UNITED STATES GEOLOGICAL SURVEY

MAP SYMBOLS

CONTACT — Boundaries of surficial deposits approximately located.

FAULT — Dashed where inferred; dotted where concealed; bar and ball on downthrown side. Arrows on cross section indicate direction of relative movement.

SYNCLINE — Showing trace of axial plane and plunge of axis; dashed where approximately located.

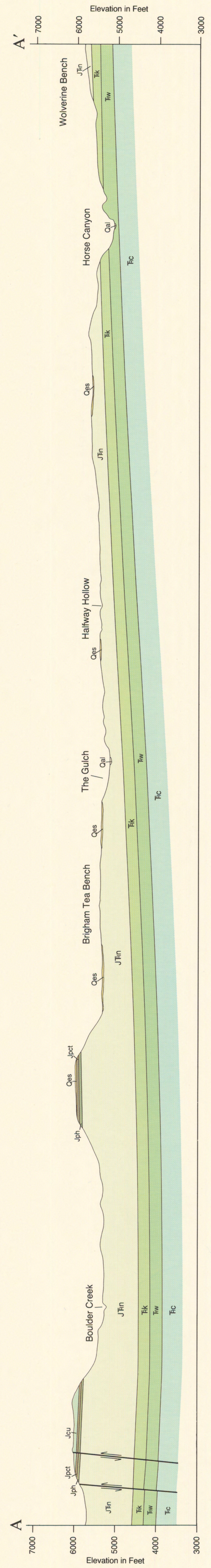
STRIKE AND DIP OF BEDS

Inclined

STRIKE OF VERTICAL AND NEAR-VERTICAL JOINTS

STRUCTURE CONTOURS — Drawn on top of Navajo Sandstone. Long dashed where control less accurate. Short dashed where datum above land surface. Contours omitted in northeast sector because of insufficient data. Contour interval 100 ft.

FORMATION	SYMBOL	THICKNESS (feet)	LITHOLOGY
Surficial deposits	Q	0-30	
High volcanic-gravel terrace alluvium	QTatv	0-30	
Upper member Carmel Formation	Jcu	180+	
Thousand Pockets Tongue of the Page Sandstone	Jpct	30-60 (50-90)	
Judd Hollow Tongue of the Carmel Formation		20-40	
Harris Wash Tongue of the Page Sandstone	Jph	40-90	
Navajo Sandstone	JꞦn	1000-1500	
Kayenta Formation	Ꞧk	200-300	
Wingate Sandstone	Ꞧw	250-350	
Chinle Formation	Ꞧc	500+	



DESCRIPTION OF MAP UNITS

Qal Floodplain alluvium — *Fine sand and silt and local admixtures of gravel.*

Qes Eolian sand — *Fine to very fine sand and silt.*

Qae Sheetwash alluvium and eolium — *Silt, sand, and small rock fragments.*

Qmfa Volcanic-gravel debris-flow colluvium and alluvium — *Angular to rounded clasts of basaltic andesite in unsorted colluvium that grades downslope to well-sorted alluvium.*

Qmts Sandstone talus — *Rockfalls of blocks and slabs of sandstone from the Kayenta Formation and Wingate Sandstone.*

Qcv Volcanic-gravel colluvium — *Rounded clasts of basaltic andesite chiefly on steep slopes.*

Qatv Volcanic-gravel terrace alluvium — *Pebbles to boulders of basaltic andesite and small amounts of clasts of sandstone as much as 200 feet above Deer and Boulder Creeks.*

Qatq Quartzite-gravel terrace alluvium — *Chiefly well-rounded cobbles of quartzite and lesser amounts of basaltic andesite and other resistant rocks on benches as much as 300 feet above the Escalante River.*

QTatv High volcanic-gravel terrace alluvium — *Pebbles to boulders of basaltic andesite and small amounts of pebbles to cobbles of chert and sandstone on a pre-canyon surface more than 650 feet above stream level.*

UNCONFORMITY

Jcu Upper member of the Carmel Formation — *Reddish-brown shale, and reddish-brown and yellowish-gray, very fine to fine-grained sandstone.*

Jpct Thousand Pockets Tongue of the Page Sandstone — *Chiefly yellowish-gray to very light gray, fine- to medium-grained sandstone; commonly contorted. Combined in map unit with underlying Judd Hollow Tongue of the Carmel Formation.*

Judd Hollow Tongue of the Carmel Formation — *Moderate-reddish-brown siltstone and light-gray to reddish-brown, fine-grained sandstone; commonly contorted.*

Jph Harris Wash Tongue of the Page Sandstone — *Grayish-orange, cross-bedded fine-grained sandstone.*

UNCONFORMITY

JꞦn Navajo Sandstone — *Chiefly grayish-orange, crossbedded, fine-grained sandstone.*

Ꞧk Kayenta Formation — *Grayish-red to dusky-red, fine-grained sandstone interbedded with lesser amounts of dusky-red siltstone.*

Ꞧw Wingate Sandstone — *Grayish-red to grayish-orange, crossbedded, fine-grained sandstone.*

UNCONFORMITY

Ꞧc Chinle Formation — *Reddish-gray, purplish-gray, and greenish-gray mudstone and siltstone and pale-red to reddish-brown, fine- to medium-grained sandstone.*

CORRELATION OF MAP UNITS

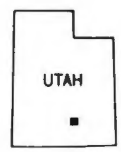
QUATERNARY	Holocene	Qal, Qes, Qae, Qmfa, Qmts, Qcv
	Holocene (?) and Pleistocene	Qatv
	Pleistocene	Qatq
QUATERNARY AND TERTIARY (?)	Pleistocene and Pliocene (?)	QTatv
UNCONFORMITY		
JURASSIC	Middle Jurassic	Jcu, Jpct, Jph
UNCONFORMITY		
JURASSIC AND TRIASSIC	Lower Jurassic and Upper Triassic (?)	JꞦn
TRIASSIC (?)	Upper Triassic (?)	Ꞧk
TRIASSIC	Upper Triassic	Ꞧw, Ꞧc

GEOLOGIC MAP OF THE KING BENCH QUADRANGLE GARFIELD COUNTY, UTAH

By

Gordon W. Weir and L. Sue Beard

U.S. Geological Survey



UTAH GEOLOGICAL AND MINERAL SURVEY

a division of

UTAH DEPARTMENT OF NATURAL RESOURCES

MAP 119 **1990**

UTAH GEOLOGICAL AND MINERAL SURVEY

606 Black Hawk Way
Salt Lake City, Utah 84108-1280

THE UTAH GEOLOGICAL AND MINERAL SURVEY is organized into four geologic programs with Administration, Editorial, and Computer Resources providing necessary support to the programs. The ECONOMIC GEOLOGY PROGRAM undertakes studies to identify coal, geothermal, uranium, hydrocarbon, and industrial and metallic mineral resources; to initiate detailed studies of the above resources including mining district and field studies; to develop computerized resource data bases; to answer state, federal, and industry requests for information; and to encourage the prudent development of Utah's geologic resources. The APPLIED GEOLOGY PROGRAM responds to requests from local and state governmental entities for engineering geologic investigations; and identifies, documents, and interprets Utah's geologic hazards. The GEOLOGIC MAPPING PROGRAM maps the bedrock and surficial geology of the state at a regional scale by county and at a more detailed scale by quadrangle. The INFORMATION GEOLOGY PROGRAM answers inquiries from the public and provides information about Utah's geology in a non-technical format.

THE UGMS manages a library which is open to the public and contains many reference works on Utah geology and many unpublished documents on aspects of Utah geology by UGMS staff and others. The UGMS has begun several computer data bases with information on mineral and energy resources, geologic hazards, stratigraphic sections, and bibliographic references. Most files may be viewed by using the UGMS Library. The UGMS also manages a sample library which contains core, cuttings, and soil samples from mineral and petroleum drill holes and engineering geology investigations. Samples may be viewed at the Sample Library or requested as a loan for outside study.

The UGMS publishes the results of its investigations in the form of maps, reports, and compilations of data that are accessible to the public. For information on UGMS publications, contact the UGMS Sales Office, 606 Black Hawk Way, Salt Lake City, UT 84108-1280, telephone (801) 581-6831.

GEOLOGIC MAP OF THE KING BENCH QUADRANGLE GARFIELD COUNTY, UTAH

By

Gordon W. Weir[1] and L. Sue Beard[1]

INTRODUCTION

The King Bench quadrangle in central Garfield County, south-central Utah, lies in the Circle Cliffs-Teasdale section of the Colorado Plateau physiographic province (Stokes, 1977). Mesas, flat-topped ridges, and uneven benches bordered by steep cliffs that descend to deep, narrow canyons form the landscape. Total relief in the quadrangle is more than 1800 feet (549 m); local relief is commonly several hundreds of feet.

Mesa tops are covered by a sparse juniper, sagebrush, and cactus desert vegetation, but much of the rocky canyon lands are bare except for hardy grasses on stable patches of sand. The perennial streams in the area, the Escalante River and its major tributaries, have large ranges in seasonal and annual flow. The greatest periods of flow are in the spring from melting of highland snow and in midsummer from sporadic torrential downpours.

The quadrangle is visited by tourists and cattlemen but it has no permanent dwellings. Boulder (1980 population, 190) about 5 miles (8 km) by road west of the quadrangle is the nearest supply point. A single maintained dirt road crosses the northern part of the quadrangle and leads eastward to uninhabited desert country. Several short unmapped jeep trails branch off the road. Most of the quadrangle is inaccessible by car and difficult to traverse on foot.

The area was included in smaller scale maps by McFall and Peterson (1971), Hackman and Wyant (1973), Doelling (1974), Sargent and Hansen (1982), and Williams (1985). Hackman (1955) prepared a photogeologic map of the quadrangle. The present geologic map is based in part on field work in 1980 assessing mineral resources of wilderness areas in Garfield County (Weir and Beard, 1981).

STRATIGRAPHY

Exposed bedrock formations range in age from Late Triassic to middle Jurassic and total more than 2600 feet (792 m) in thickness. Thin surficial deposits cover large parts of the quadrangle.

TRIASSIC SYSTEM

Upper Triassic Series

Chinle Formation ℞c — The Chinle Formation consists chiefly of reddish-, purplish-, and greenish-gray mudstone and siltstone, in part bentonitic, interstratified with lesser amounts of pale-red, reddish-gray, and reddish-brown, fine- to medium-grained, locally pebbly, sandstone. It crops out poorly on moderate to very steep slopes below cliffs of the Wingate Sandstone. Slabs of sandstone from the Wingate Sandstone and the Kayenta Formations cover much of the Chinle slopes. The base of the Chinle is not exposed in this quadrangle; about 500 feet (152 m) of the formation is present in the northeast corner. The Chinle ranges from about 500 to 740 feet (152-225 m) in thickness in adjacent areas to the east (Davidson, 1967, p. 24).

Wingate Sandstone (℞w) — A grayish-red to grayish-orange sandstone, it is composed of well-sorted, very fine to fine, subrounded grains of quartz that are firmly cemented by calcite and iron oxide. In the northeast corner of the quadrangle the formation is altered to very light yellowish gray, probably by leaching of ferric iron by ground water (Davidson, 1967,

[1]*Geologist, U.S. Geological Survey, Flagstaff, Arizona*

p. 36). The sandstone is in planar and trough sets, commonly 2-20 feet (.6-6 m) thick, of high-angle crossbeds interlayered rarely with thin sets of tabular beds. The base of the formation is a minor unconformity marked by a distinctive bed, only 4-6 inches (19-15 cm) thick, of medium-gray to reddish-gray sandstone containing abundant granules of quartz. The Wingate forms sheer cliffs along canyons in the eastern part of the quadrangle. The cliff faces are irregularly stained purplish black by desert varnish, a coating of iron and manganese oxides. The formation ranges from about 250 to 350 feet (76-106 m) thick in the King Bench quadrangle.

Upper Triassic(?) Series

Kayenta Formation (T̶k) — The Kayenta Formation consists of sandstone and lesser amounts of siltstone. The grayish-red to dusky-red sandstone is composed chiefly of fine grains of quartz, feldspar, and mica cemented by calcite. The sandstone is mostly in small- to medium-scale sets of horizontal beds and planar and trough sets of crossbeds. Dusky-red siltstone is in thin sets of tabular beds irregularly interstratified with sandstone. The Kayenta forms steep, ledgy slopes and extensive irregular benches in the eastern part of the quadrangle. Outcrops shed abundant slabs of sandstone onto slopes below. Upper and lower contacts are commonly obscure in a zone, 20-100 feet (6-30 m) thick, of transitional lithology characterized by alternating units of crossbedded sandstone and planar beds of siltstone and sandstone. The formation ranges from about 200 to 300 feet (60-90 m) in thickness in this quadrangle.

TRIASSIC(?) AND JURASSIC SYSTEMS

Upper Triassic(?) and Lower Jurassic Series

Navajo Sandstone (JT̶n) — The formation is composed almost wholly of well-sorted, subrounded, frosted, very fine to medium grains of clear quartz and very small amounts of white chert and feldspar. The sandstone is mostly very light grayish orange, but reddish-gray to yellowish-orange rock is conspicuous in much of this quadrangle. Reddish-orange to black iron staining occurs sporadically. The rock is poorly to well cemented by calcite and weathers to loose sand. The sandstone is characterized by large-scale trough sets, commonly 6 to 18 feet (1.8-5.4 m) thick, of high-angle crossbeds. Contorted beds are locally common; tabular beds are rare. Grayish-red siltstone is irregularly interstratified in sparse thin lenses, mostly near the base of the formation. The formation erodes to form towering cliffs, fin-like ridges, irregularly rounded knobs, and hummocky mesa tops, which are commonly mantled with a thin layer of locally derived sand. The thickness of the Navajo is between 1000 and 1500 feet (304-457 m) as indicated in nearby areas by measurements of outcrops (Davidson, 1967, p. 37) and by logs of exploratory wells (Heylmun and others, 1965, p. 68-71, and unpublished records in the files of the U.S. Bureau of Land Management, Salt Lake City, Utah).

JURASSIC SYSTEM

Middle Jurassic Series

Harris Wash Tongue of the Page Sandstone (Jph) — The lower tongue of the Page Sandstone is light- to moderate-grayish-orange, fine-grained quartz sandstone in large-scale trough sets, commonly 3 to 18 feet (1-5.4 m) thick. The Harris Wash is lithologically similar to the underlying Navajo Sandstone and was included in the Navajo by most previous workers. It is separated from that formation by an obscure unconformity marked by sparse granules and very small pebbles of chert (Peterson and Pipiringos, 1979, p. 20-29). It is separated from the overlying Thousand Pockets Tongue of the Page Sandstone by the Judd Hollow Tongue of the Carmel Formation. The Harris Wash forms a ledge that caps cliffs and mesas of Navajo Sandstone. The tongue ranges in thickness from about 40 to 90 feet (12-27 m).

Thousand Pockets Tongue of the Page Sandstone (Jpct) — The upper tongue is mostly yellowish-gray to very light gray, fine- to medium-grained quartz sandstone. A conspicuous layer, as much as 10 feet (3 m) thick, of reddish-brown calcitic siltstone lies near the middle of the tongue. Trough and planar sets of crossbeds are dominant in the sandstone, but tabular beds occur. Much of the bedding is wavy and locally the whole unit is contorted. The tongue forms a ledge that caps several mesas and ranges irregularly in thickness from about 30 to 60 feet (9-18 m). It is combined with the underlying thin Judd Hollow Tongue of the Carmel Formation as map unit Jpct.

Judd Hollow Tongue of the Carmel Sandstone (Jpct) — This tongue, interstratified between tongues of the Page Sandstone, consists of thin beds of moderate-reddish-brown siltstone and light-gray to reddish-brown fine-grained sandstone. The base is commonly marked by a thin set, several inches to a few feet thick, of tabular beds of iron-stained sandstone. Above the basal set, beds are commonly wavy and in places markedly contorted along with beds in the overlying Thousand Pockets Tongue of the Page Sandstone. The Judd Hollow is a poorly exposed, slope-forming unit of uneven thickness ranging from about 20 to 40 feet (6-12 m). The tongue is too thin to map separately; it forms the lower part of the map unit labelled Jpct.

Upper member of the Carmel Formation (Jcu) — This unit within the quadrangle is composed of interbedded shale, siltstone, and sandstone. The clayey to silty shale and siltstone are reddish brown mottled by greenish gray and light grayish yellow. The sandstone is moderate reddish brown and yellowish gray, very fine to fine grained, commonly silty, and poorly to firmly cemented by calcite and iron oxides. Only the lower part of the upper member is exposed on mesa tops near the west edge of the quadrangle. The thickest outcrop, about 180 feet (55 m), is on a small mesa northeast of the mouth of Boulder Creek.

TERTIARY(?) AND QUATERNARY SYSTEMS

Pliocene(?) and Pleistocene Series

High volcanic-gravel terrace alluvium (QTatv) — This alluvium caps mesas near the west edge of the quadrangle and a ridge about a mile east of the junction of Long Canyon and The Gulch. It is composed mainly of rounded cobbles and boulders, as much as 4 feet (1.2 m) across, of dark-gray to dark-brown basaltic andesite and minor amounts of other volcanic rocks in a matrix of pebbles and sand. Locally, near the base of the deposits are cobbles of sandstone from the local bedrock, the Navajo Sandstone or Carmel Formations. Yellow-brown, red, and orange chert in irregular blocks and small rounded pebbles of black chert are sparse but locally conspicuous. The poorly consolidated deposits are irregularly cemented with calcite. Many boulders and cobbles are coated in whole or part with white to light-yellowish-gray, pedogenic calcium carbonate. Bedding is obscure, but a few exposures in adjoining areas display crudely graded beds and trough sets of crossbeds in channel fills. Some outcrops are veneered irregularly by wind-blown sand. These volcanic gravels are remnants of stream deposits, probably derived from debris slides and flows from the volcanic terrane of the Aquarius Plateau about 10 miles (3 m) northwest of this quadrangle (Williams, 1985). The gravels are the same as the pediment gravels of Hackman and Wyant (1973, sheet 1) and Weir and Beard (1981a) and the high volcanic-gravel terrace alluvium (Tv_3) of Williams (1985). The deposits lie more than 650 feet (198 m) above stream level on a gently southward-sloping and truncating surface that predates canyon cutting by the Escalante River and its tributaries. The deposits attain a maximum thickness of about 30 feet (9 m) on an unnamed mesa in the northwest corner of the quadrangle.

QUATERNARY SYSTEM

Pleistocene Series

Quartzite-gravel terrace alluvium (Qatq) — These unconsolidated gravels are composed of well-rounded pebbles to cobbles, as much as 8 inches (20 cm) in diameter, of light-gray, light-brownish-gray, reddish-gray, and very dark gray quartzite, chert, and fine-grained metamorphic rocks and pebbles to boulders of dark-gray to dark-brown, vesicular basaltic andesite. The quartzite, chert, and metamorphic rocks are derived from Cretaceous or Tertiary formations cropping out west or north of the quadrangle. The basaltic andesite is derived from the volcanic terrane of the Aquarius Plateau. The sparse matrix is light-brown, fine to medium sand. The deposits form irregular sheets and heaps of stones, covered locally by thin patches of windblown sand. The gravels are probably as much as 30 feet (9 m) thick and rest on benches cut in the Navajo Sandstone near the mouth of Boulder Creek about 300 feet (90 m) above the Escalante river. They are equivalent to the high quartzite-cobble terrace alluvium (tq_3) of Williams (1985).

Pleistocene and Holocene(?) Series

Volcanic-gravel terrace alluvium (Qatv) — Gravels along Deer Creek and Boulder Creek are composed chiefly of rounded pebbles to boulders of dark-gray to dark-brown vesicular andesite and a minor admixture of pebbles to cobbles of sandstone. The sparse matrix is dark-brown, fine to medium sand. The deposits are unconsolidated and form irregular heaps and blankets of stones, probably as much as 20 feet (6 m) thick, perched on benches about 100 to 200 feet (30-60 m) above stream level. These gravels, probably of several generations, are mostly equivalent to the intermediate volcanic-gravel terrace alluvium (tv_2) of Williams (1985) but also include the distal alluvial facies of the volcanic debris-flow colluvium and alluvium (fdv) of Williams (1985).

Holocene Series

Volcanic-gravel colluvium (Qcv) — These unconsolidated deposits consist chiefly of rounded cobbles and boulders of basaltic andesite and a few clasts of Navajo Sandstone in a matrix of dark-brown, pebbly sand. The material was derived mainly by creep and sliding from the high volcanic-gravel terrace alluvium (QTatv). Most of the deposits are probably intermittently active on steep slopes of Navajo Sandstone in the western part of the quadrangle. The colluvium on slopes of the mesa near the northwest corner of the quadrangle is estimated to be as much as 10 feet (3 m) thick. Contacts are generalized; small patches of the colluvium are not shown.

Sandstone talus (Qmt) — In the eastern part of the quadrangle blocks and slabs of sandstone from the Kayenta Formation and Wingate Sandstone have piled up in small fans and irregular blankets on slopes below the top of the Wingate. Much of the sandstone debris, though abundant, is too scattered to form a discrete body. The deposits are probably as much as 20 feet (6 m) thick near their toes.

Sheetwash alluvium and eolium (Qae) — These deposits, formed by water flowing in sheets and shallow channels and locally modified by wind, consist of yellowish-brown to dark-reddish-brown and grayish-orange-pink silt, sand, and small rock fragments. They commonly contain and intergrade with windblown sand. They form relatively smooth-surfaced patches on flats and gentle slopes on the Navajo Sandstone. Only the larger patches are shown. These deposits are probably not more than 15 feet (4.5 m) thick.

Eolian sand (Qes) — These deposits are dominantly windblown sand, but reworking by sheetwash is common. In places the eolium includes sandy residuum only partly modified by wind. The sand is mostly very fine to fine grained and yellowish gray to pale red. Sand on the small mesa about 1 mile (1.6 km) northeast of the mouth of Boulder Creek is mostly residual and includes reddish-brown silt and small angular fragments of pale-red sandstone and siltstone from the Carmel Formation. Most eolian sand is locally derived from sandstone bedrock and forms broad thin sheets on irregular surfaces. The most extensive deposits are on Navajo Sandstone benches. Distinct dune forms are lacking but a few sand sheets have northeast-trending ridges. Some sand is stabilized by desert grasses, but most of the sheets are probably altered during windstorms. Only the larger sand sheets are shown. The eolian sand is probably as much as 20 feet (6 m) thick on Brigham Tea Bench in the southern part of the quadrangle.

Floodplain alluvium (Qal) — Alluvium on modern floodplains, on low terraces, and in narrow channels in this quadrangle consists of yellowish-gray to grayish-orange-pink silt and fine sand and variable admixtures of pebbles to boulders of basaltic andesite, quartzite, and sandstone. Ripple laminations, trough crossbedding, graded bedding, and imbricated gravels occur locally in these deposits. Alluvium mapped along Deer Creek includes gravel assigned by Williams (1985) to low volcanic-gravel terrace alluvium (tv_1). The channel of Deer Creek is on Navajo Sandstone. Alluvium in the Gulch near the mouth of Long Canyon includes about 20 feet (6 m) of pre-modern light-brown silt in narrow terraces along canyon walls.

STRUCTURAL GEOLOGY

The dominant structure in the King Bench quadrangle is a homocline dipping about 2 to 4 degrees southwesterly into the Durffey Mesa syncline, the axis of which lies near the west edge of the quadrangle. The east flank of the fold dips gently southwesterly while the west flank dips as much as 11 degrees northeasterly. Hackman and Wyant (1973, sheet 2) included this syncline in a regional downfold, the Harris Wash syncline.

The west flank of the Durffey Mesa syncline is cut by two minor faults. The maximum offset is about 50 feet (15 m) in sec. 8, T. 35 S., R. 5 E. on the easternmost fault, which continues more than 4 miles (6.4 km) to the southeast (Weir and Beard, 1981).

The Navajo Sandstone, which crops out over much of the quadrangle, is cut locally by many vertical and near-vertical joints The joints are mostly closely spaced and, although obscure in places, are generally conspicuous because they control small topographic forms. Not all joints are mapped; the symbols represent conspicuous sets of joints. Except in the southwest corner of the quadrangle where joints parallel northwest-striking faults, rectilinear northeast trends are dominant.

ECONOMIC GEOLOGY

The King Bench quadrangle area contains no mines or prospects. Geochemical reconnaissance, which included the quadrangle and adjoining areas, did not indicate the presence of mineral terranes (Weir and Lane, 1981a, b, 1983).

Small, low-grade uranium-copper deposits are in the basal part of the Chinle Formation in the Circle Cliffs about 15 miles (24 km) east of this quadrangle (Davidson, 1967, p. 65-91; Doelling, 1975, p. 107-109, 131-135). The base of the Chinle underlies this quadrangle at depths of a few hundred to several thousands of feet. It perhaps contains similar deposits, but because of their small size and low grade they are unlikely to warrant exploration.

Although oil and gas is produced from a fold in Triassic and Permian strata about 25 miles (40 km) west of Durffey Mesa (Peterson, 1973; Sharp, 1976), the petroleum potential of this quadrangle is low because no structural traps are apparent. Stratigraphic traps within the deeply buried rocks are possible, but none has been found in the region.

The major natural resource in the quadrangle is the magnificent canyon and rock-monument scenery. Many hikers traverse the desert and streamside trails (U.S. Bureau of Land Management, 1979; Lambrechtse, 1985).

GEOLOGIC HAZARDS

Floods are the chief natural hazard in the King Bench quadrangle. Summertime cloudbursts in the quadrangle or adjacent areas can result in rock-laden floods suddenly coursing down narrow canyons. In addition, temporary dams formed by rockfalls may give way to release an unexpected torrent far downstream. Hikers traversing the cliff-and-canyon country should beware of falling rocks as well as flash floods. Areas of quicksand are a possible danger along the major streams. Drivers venturing on jeep trails should be prepared to deal with thick patches of loose sand.

Care should be taken for any construction on surficial deposits. Alluvial and eolian sand (Qae, Qes) may be unstable even on moderate slopes. The Chinle Formation (₮c) is generally unsuitable for foundations and excavations because it contains layers of mudstone and siltstone that swell when wet.

Seismic risks in the quadrangle appear minimal because the known faults in the region have small displacements and show no evidence of geologically recent movement. Only two earthquakes of magnitude 4.0 or greater centered in eastern Garfield county have been recorded (Ward, 1979, fig. 1). The King Bench quadrangle lies in the relatively inactive seismic zone U-1 (on a scale of 1 to 4) of the Utah Uniform Building Code (Ward, 1979, fig. 3). Earthquakes reflected from more tectonically active areas, however, may cause rockfalls or sliding of slope deposits.

REFERENCES

Davidson, E.S., 1967, Geology of the Circle Cliffs area, Garfield and Kane Counties, Utah: U.S. Geological Survey Bulletin 1229, 140 p.

Doelling, H.H., 1974, Geology of Garfield County, Utah: Utah Geological and Mineral Survey Map, scale 1:250,000.

——1975, Geology and mineral resources of Garfield County, Utah: Utah Geological and Mineral Survey Bulletin 107, 175 p.

Hackman, R.J., 1955, Photogeologic map of the Circle Cliffs-6 quadrangle, Garfield County, Utah: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-22, scale 1:24,000.

Hackman, R.J., and Wyant, D.G., 1973, Geology, structure, and uranium deposits of the Escalante quadrangle, Utah and Arizona: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-744, scale 1:250,000, 2 sheets.

Heylmun, E.B., Cohenour, R.E., and Kayser, R.B., 1965, Drilling records for oil and gas in Utah, January 1, 1954-December 31, 1963: Utah Geological and Mineralogical Survey Bulletin 74, 518 p.

Lambrechtse, Rudi, 1985, Hiking the Escalante: Salt Lake City, Utah, Wasatch Publishers, 192 p.

McFall, C.C., and Peterson, P.R., 1971, Geology of the Escalante-Boulder area, Garfield County, Utah: Utah Geological and Mineralogical Survey Map 31, scale 1:62,500.

Peterson, Fred, and Pipiringos, G.N., 1979, Stratigraphic relations of the Navajo Sandstone to middle Jurassic formations, southern Utah and northern Arizona: U.S. Geological Survey Professional Paper 1035-B, 43 p.

Peterson, P.R., 1973, Upper Valley Field: Utah Geological and Mineral Survey Oil & Gas Field Studies 7.

Sargent, K.A., and Hansen, D.E., 1982, Bedrock geologic map of the Kaiparowits coal-basin area, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I-1033-I, scale 1:250,000.

Sharp, G.C., 1976, Reservoir variations at Upper Valley field, Garfield County, Utah:Rocky Mountain Association of Geologists 1976 Symposium, p. 325-344.

Stokes, W.L., 1977, Subdivision of the major physiographic provinces in Utah: Utah Geology, v. 4, no. 1, p. 1-18.

U.S. Bureau of Land Management, 1979, Hiking the Escalante River, map scale 1:63,360.

Ward, D.B., 1979, Seismic zones for construction in Utah: Utah Seismic Safety Advisory Council, 13 p.

Weir, G.W., and Beard, L.S., 1981, Geologic map of the Escalante Canyon Instant Study Area, Garfield County, Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-1313-A, scale 1:48,000.

Weir, G.W., and Lane, M.E., 1981a, Mineral resources of the Phipps-Death Hollow Instant Study Area, Garfield County, Utah: U.S. Geological Survey Open-File Report 81-558, 15 p.

——1981b, Mineral resources of the Escalante Canyon Instant Study Area, Garfield County, Utah: U.S. Geological Survey Open-File Report 81-559, 17 p.

—1983, Mineral resource potential map of The Box-Death Hollow Roadless Area, Garfield County, Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-1319-B, scale 1:48,000.

Williams, V.S., 1985, Surficial geologic map of the Kaiparowits coal-basin area, Utah: U.S. Geological Survey Miscellaneous Investigations Map I-1033-L, scale 1:125,000.