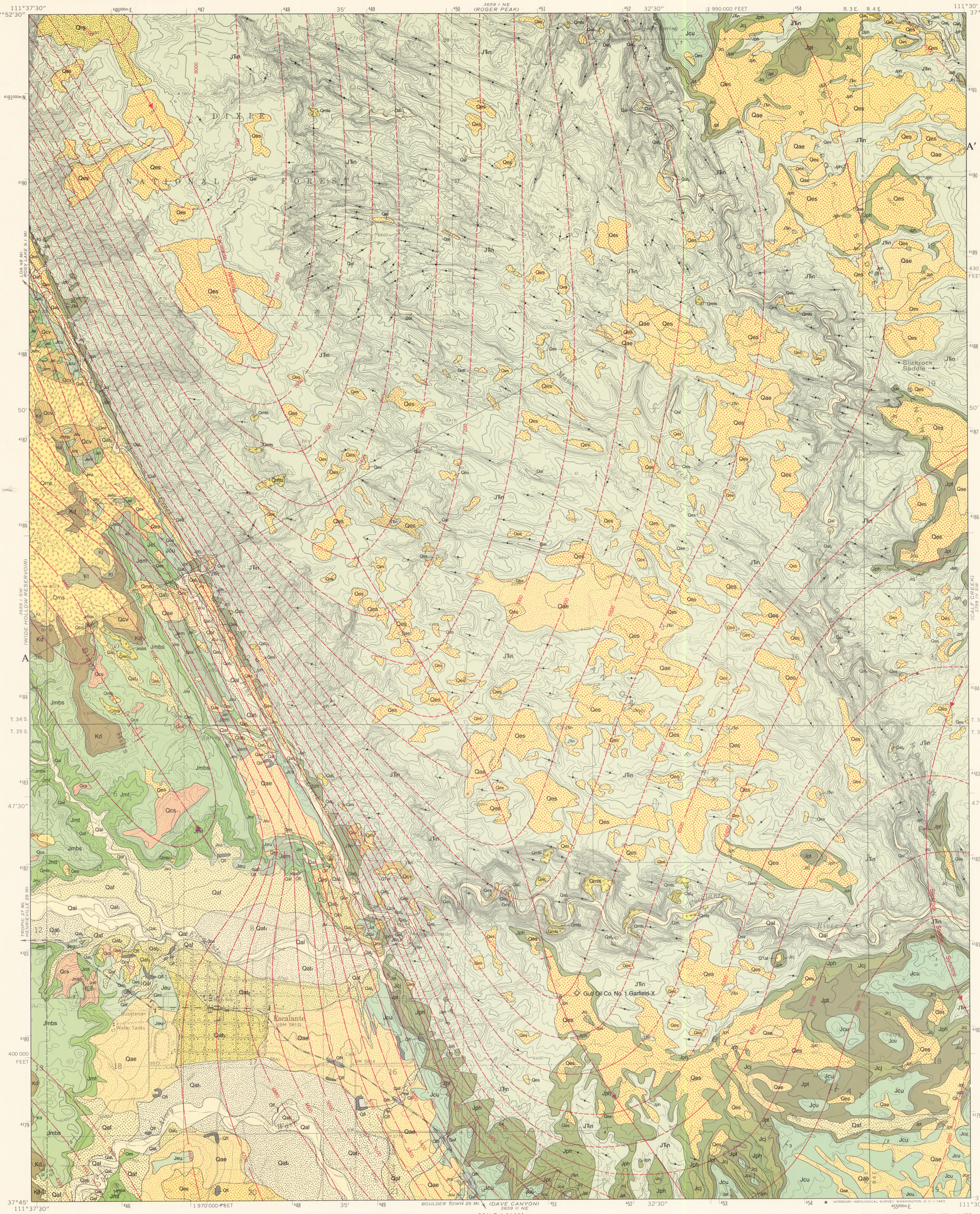
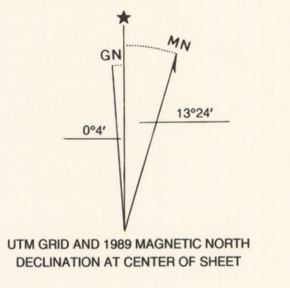
UTAH GEOLOGICAL AND MINERAL SURVEY
UTAH DEPARTMENT OF NATURAL RESOURCES
in cooperation with
THE UNITED STATES GEOLOGICAL SURVEY

Plate 1
Utah Geological and Mineral Survey Map 116
Geologic Map of the Escalante Quadrangle



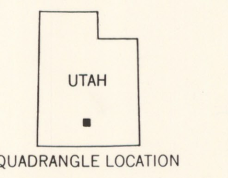
Base map from U.S. Geological Survey, Escalante Quadrangle 1964

SCALE 1:24 000



CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 20-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

UTM GRID AND 1989 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET



QUADRANGLE LOCATION

Field mapping by authors in 1978, 1980 and 1986
Kent D. Brown, Patricia H. Speranza, Cartographers

GEOLOGIC MAP OF THE ESCALANTE QUADRANGLE, GARFIELD COUNTY, UTAH

by
Van S. Williams, 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

CONTACT — Boundaries of surficial deposits approximately located.

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

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

STRIKE AND DIP OF BEDS

5 Inclined

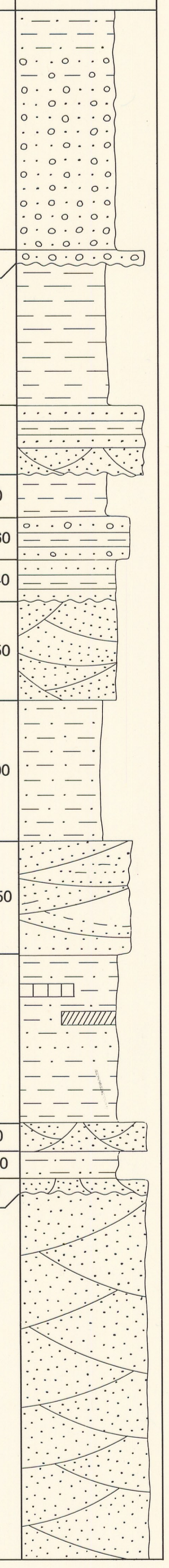
STRIKE OF VERTICAL AND NEAR-VERTICAL JOINTS

MANGANESE PROSPECT

OIL WELL — Dry hole, showing name of well.

STRUCTURE CONTOURS — Drawn on top of Navajo Sandstone. Long dashed where control less accurate. Short dashed where datum above land surface. Contour interval 100 ft.

FORMATION		SYMBOL		THICKNESS (feet)		LITHOLOGY
Surficial deposits		Q		0-200		
High terrace alluvium		QTatv		0-30		
Tropic Shale		Kt		300+		
Dakota Formation		Kd		130-170		
Morrison Formation	Brushy Basin member	Jm (cross section)	Jmbs	250-450	0-150	
	Salt Wash member				120-160	
	Tidwell member		Jmt		120-140	
Entrada Sandstone	Upper member	Je (cross section)	Jeu	750-1000	200-250	
	Middle member		Jem		300-400	
	Lower member		Jel		250-350	
Carmel Formation	Upper member	Jcu		350-400		
Page	Thousand Pockets Tng.	Jpct (cross section)	Jpt	140-180	30-80	
Carmel	Judd Hollow Tongue		Jcj		20-110	
Page	Harris Wash Tongue		Jph		10-50	
Navajo Sandstone		JTRn		780+		



DESCRIPTION OF MAP UNITS

Qfh / Qfl — Artificial fill — *Unsorted gravel, sand, and silt used as highway fill (Qfh) and for stock-pond dams and landfills (Qfl).*

Qes — Windblown sand — *Fine grains of quartz and minor silt.*

Qrs — Sandy residuum — *Fine grains of quartz and small fragments of sandstone.*

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

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

Qat_1 — Fine-grained terrace alluvium — *Silt, fine sand and minor gravel on terraces 5 to 15 feet above stream level.*

Qcs — Sandstone-boulder colluvium — *Subangular clasts, as much as 10 feet across, of sandstone and chert-pebble conglomerate.*

Qmts — Sandstone talus — *Rockfalls of sandstone below cliffs of the Morrison Formation and Navajo Sandstone.*

Qaf — Fan allluvium — *Silt, sand, and sparse to abundant gravel of local derivation.*

Qcv — Volcanic-boulder colluvium — *Boulders and smaller clasts of basaltic andesite.*

Qmb — Block-slide deposits — *Large slide blocks of sandstone and shale of the Dakota Sandstone.*

Qms — Debris-slide colluvium — *Irregular masses of boulders and smaller clasts of basaltic andesite and at the base irregular masses of shale.*

Qat_2, Qat_3 — Low quartzite- and volcanic-gravel terrace alluvium — *Chiefly boulders and cobbles of basaltic andesite and quartzite on terraces about 40 feet (Qat_2) and 60 feet (Qat_3) above stream level.*

Qat_4, Qat_5 — Intermediate volcanic-gravel terrace alluvium — *Chiefly boulders and cobbles of basaltic andesite on terraces about 180 feet (Qat_4) and 260 feet (Qat_5) above stream level.*

QTatv — High volcanic-gravel terrace alluvium — *Chiefly boulders and cobbles of basaltic andesite or an erosion surface 400 feet or more above stream level.*

UNCONFORMITY

Kt — Tropic Shale — *Dark-greenish-gray shale.*

Kd — Dakota Formation — *Light-brown sandstone, carbonaceous shale and siltstone, and minor coal.*

UNCONFORMITY

Jm (cross section)

Morrison Formation

Jmbs — Brushy Basin and Salt Wash Members, undivided — *Pinkish- and yellowish-gray sandstone and conglomerate and gray, green, brown, and purple mudstone.*

Jmt — Tidwell Member — *Chiefly light-gray sandstone and reddish-brown and green sandstone.*

UNCONFORMITY

Je (cross section)

Entrada Sandstone

Jeu — Upper member — *Light-gray to pale-orange, fine-grained crossbedded sandstone.*

Jem — Middle member — *Chiefly reddish-brown, thin-bedded silty sandstone and red and gray sandy siltstone and mudstone.*

Jel — Lower member — *Chiefly reddish-brown, crossbedded, fine-grained sandstone and minor mudstone and siltstone.*

Jcu — Carmel Formation, upper member — *Reddish-brown shale, yellowish-brown fine-grained sandstone, gray micrograined limestone, and gypsum.*

Jpct (cross section)

Jpt — Page Sandstone, Thousand Pockets Tongue — *Chiefly yellowish-gray to very light gray, crossbedded, fine- to medium- grained sandstone, commonly contorted.*

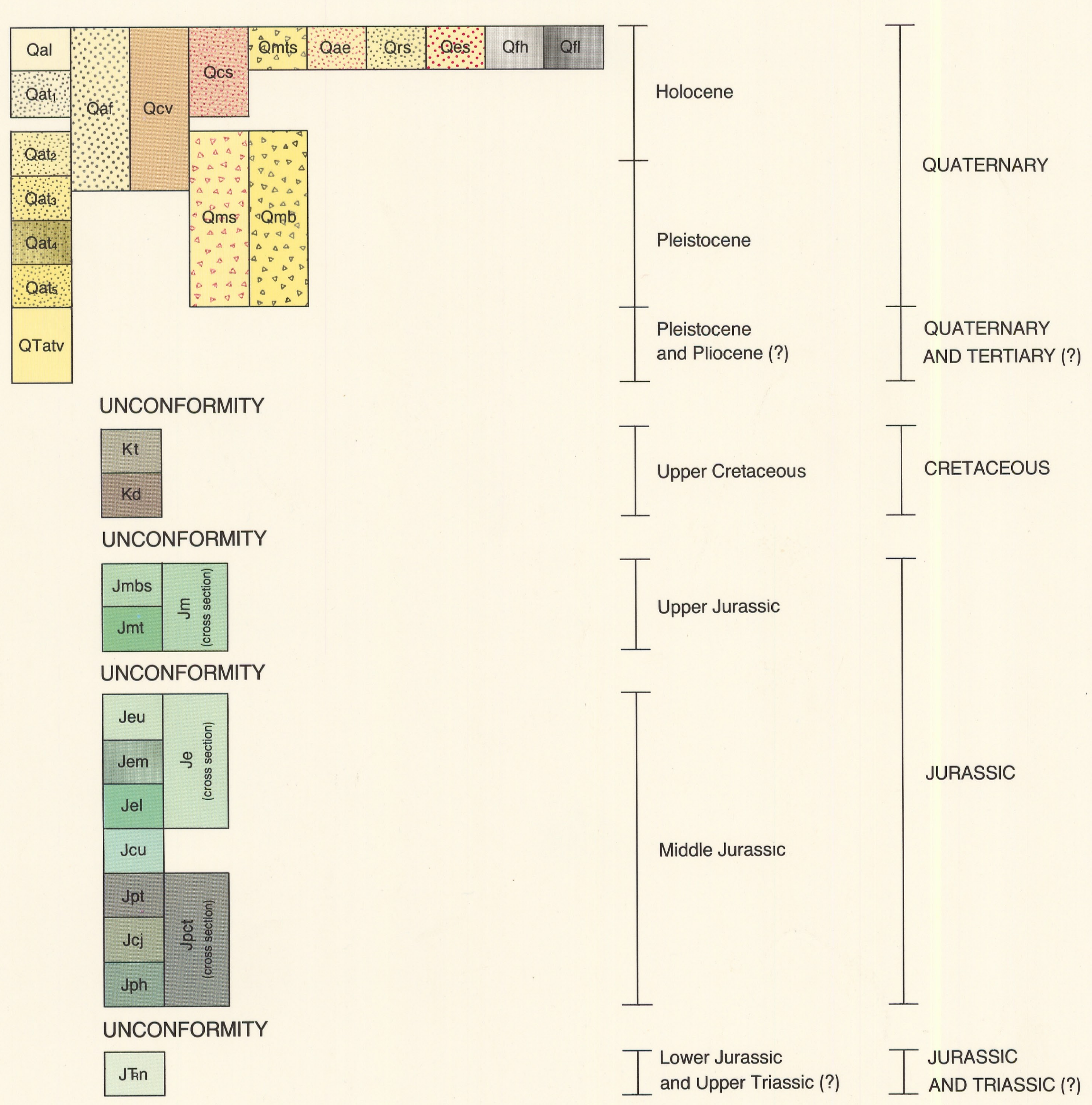
Jcj — Carmel Formation, Judd Hollow Tongue — *Chiefly reddish-brown siltstone and fine-grained sandstone; commonly contorted.*

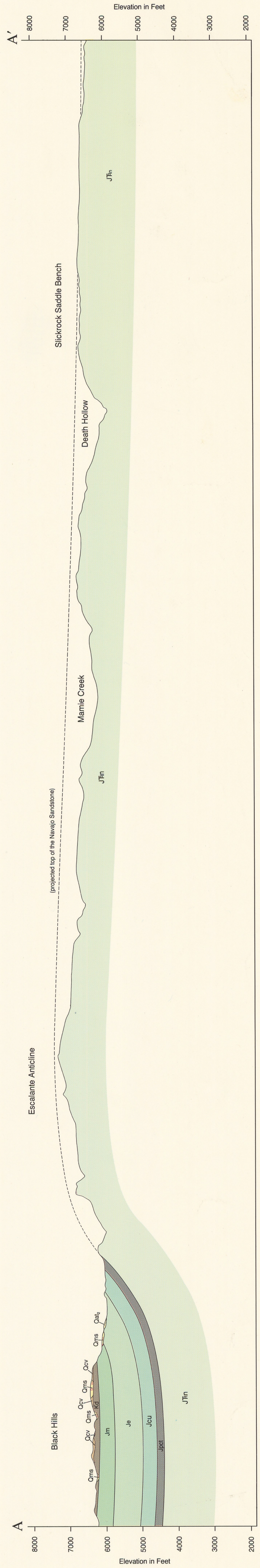
Jph — Page Sandstone, Harris Wash Tongue — *Light-grayish orange, crossbedded, fine-grained sandstone.*

UNCONFORMITY

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

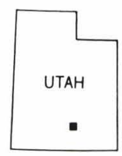
CORRELATION OF MAP UNITS





GEOLOGIC MAP OF THE ESCALANTE QUADRANGLE, GARFIELD COUNTY, UTAH

By
Van S. Williams, 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 116 **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 ESCALANTE QUADRANGLE GARFIELD COUNTY, UTAH

By Van S. Williams,[1] Gordon W. Weir,[2] and L. Sue Beard[2]

INTRODUCTION

The Escalante quadrangle is in central Garfield County. The western part of the quadrangle lies in the Kaiparowits Plateau-Escalante Benches section, and the eastern part is in the Circle Cliffs-Teasdale anticlines section of the Colorado Plateau physiographic province (Stokes, 1977). Except for lowland flats near Escalante and the irregular mesas of the Black Hills in the western part of the quadrangle, the rugged landscape is formed by benches of bare rock bordered by irregular steep cliffs that descend to deep, narrow canyons. Total relief in the quadrangle is about 2480 feet (756 m).. The principal streams, the Escalante River and its tributary Pine Creek, have large seasonal and annual changes in flow. The major periods of flow are usually in early spring, in response to melting of highland snow, and in midsummer as a result of sporadic torrential downpours. Escalante (1980 population, 652) is the largest town and the main supply center for central and eastern Garfield County. The paved highway in the southwestern part of the quadrangle connects Escalante with towns to the west and northeast. An improved dirt road along Pine Creek leads northward to pine and aspen forests. Most of the quadrangle is inaccessible by car, and much is difficult to traverse on foot. Farming, lumbering, and serving the tourist trade are the chief occupations. Although the quadrangle contains a manganese prospect, insufficient exploration has been done to determine the mineral potential of the quadrangle.

The area was included in smaller scale geologic maps by McFall (1956), McFall and Peterson (1971), Hackman and Wyant (1973), Doelling (1974), Sargent and Hansen (1982), and Williams (1985). Detterman (1955) compiled a photogeologic map of the quadrangle at the 1:24,000 scale. The present geologic map is based primarily on the field work of V.S. Williams in 1978. The nomenclature of surficial deposits is based on the classification he developed in mapping the surficial deposits of the Kaiparowits coal-basin area (Williams, 1985). L. Sue Beard, assisted by D. C. Ferris in 1980, and G. W. Weir in 1980 and 1986 added details of the Morrison Formation and the Entrada and Page Sandstone.

STRATIGRAPHY

Bedrock formations exposed in the Escalante quadrangle range in age from Triassic (?) and Jurassic to Upper Cretaceous, and total about 3200 feet (975 m) in thickness. Thin Quaternary surficial deposits cover much of the area.

TRIASSIC(?) AND JURASSIC SYSTEMS

Upper Triassic(?) and Lower Jurassic Series

Navajo Sandstone (JŦn)— The formation is composed of well-sorted, subrounded, frosted, very fine to medium but chiefly fine grains of clear quartz and very small amounts of white chert and feldspar. The sandstone is mostly very light grayish orange, but locally reddish-gray to yellowish-orange rock is conspicuous. Iron staining, ranging from reddish orange to black, occurs sporadically. The rock is poorly to well cemented by calcite and readily weathers to yield loose sand. The sandstone is characterized by large-scale trough sets, commonly 6 to 18 feet (1.8-5.5 m) thick, of high-angle crossbeds. Contorted beds are locally common; horizontal beds are rare. Grayish-red siltstone is irregularly interstratified in sparse thin lenses. The formation erodes to form towering cliffs, fin-like ridges, irregularly rounded knobs, and hummocky mesa tops, commonly mantled with a thin layer of locally derived sand. In the Escalante quadrangle the base of the formation is below drainage; about 780 feet (238 m) is exposed. The total thickness of the Navajo is about 1500 feet (460 m) as indicated by logs of exploratory wells in the area (Heylmun and others, 1965, p. 68-71).

[1]*U.S. Geological Survey, Denver, Colorado*
[2]*U.S. Geological Survey, Flagstaff, Arizona*

JURASSIC SYSTEM

Middle Jurassic Series

Harris Wash Tongue of The Page Sandstone (Jph)— The lower tongue of the Page Sandstone is light-grayish-orange, fine-grained quartz sandstone in large-scale trough sets, commonly 3 to 18 feet (1-5.5 m) thick. Horizontal beds, a few inches to a few feet thick and locally iron stained, characterize the top few feet of the tongue. 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 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 carved in the Navajo Sandstone. The tongue attains its greatest thickness of about 50 feet (15 m) near the southeast corner of the quadrangle, and thins northwestward along Pine Creek to about 10 feet (3 m) at the west edge of the quadrangle.

Thousand Pockets Tongue of the Page Sandstone (Jpt)— The upper tongue of the Page Sandstone is mostly yellowish-gray to very light gray, fine- to medium-grained quartz sandstone. A conspicuous layer, 3 to 9 feet (1-3 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 horizontal beds occur. Much of the bedding is wavy, and locally the whole unit is contorted. The tongue forms a ledge that caps mesas in southern and eastern parts of quadrangle and forms flatirons along the east side of Pine Creek. The Thousand Pockets is irregular in thickness, ranging from about 30 to 80 feet (9-24 m). The Thousand Pockets and Harris Wash Tongues of the Page Sandstone and the interstratified Judd Hollow Tongue of the Carmel Formation are combined into a single unit (Jpct) in the cross section; the combined tongues range from about 140 to 180 feet (43-55 m) in thickness.

Judd Hollow Tongue of the Carmel Formation (Jcj)— This unit, interstratified between tongues of the Page Sandstone, consists of moderate-reddish-brown siltstone, light-gray to reddish-brown fine-grained sandstone, and yellowish-gray to pale-orange very fine-grained limestone. Much of the bedding is wavy, and in places the whole unit is contorted along with the overlying Thousand Pockets Tongue of the Page Sandstone. The Judd Hollow is a poorly exposed slope-forming unit of irregular thickness ranging from about 20 to 110 feet (6-33 m) that generally thickens northward.

Upper member of the Carmel Formation (Jcu)— The upper member of the Carmel constitutes the bulk of the formation and is composed of shale and sandstone interbedded with lesser amounts of limestone and gypsum. The shale is silty to clayey, commonly calcitic, reddish brown mottled with 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 locally by gypsum and iron oxides. It is mostly in thin horizontal beds but locally is in thin lenses of crossbeds. The limestone is light gray and yellowish gray, micrograined, and in places silty and dolomitic. The limestone is in ledge-forming sets of laminae and thin beds, commonly crinkled, and weathers to yield abundant platy fragments. Shell fragments occur in a few beds. Peterson and Pipiringos (1979, p. 38-39) noted poorly preserved shells of the pelecypod *Pronoella uintahensis* (Imlay) in limestone, about 103 feet (31 m) above the base of the upper member in a section measured near Pine Creek in SW 1/2 sec. 29, SE 1/4 sec. 30 (projected), T. 34 S., R. 3 E. Gypsum, mostly light gray, locally reddish brown and yellowish green, commonly clayey to fine sandy, occurs in sets, as much as 10 feet (3 m) thick, of irregular thin beds. The gypsum layers and enclosing beds are slightly to very contorted. The upper member is generally exposed poorly on an irregular slope interrupted by minor ledges. It is about 350 to 400 feet (107-122 m) thick in exposures along Pine Creek thickening northwestward to about 750 feet (230 m) in the adjacent Wide Hollow Reservoir quadrangle (Stephens, 1973, sheet 2).

Lower member of the Entrada Sandstone (Jel)— The basal member of the Entrada is reddish-brown to light-gray, cross-bedded, very fine to fine-grained, in part silty, sandstone. Interstratified with the sandstone are sparse sets of dusky-red mudstone and very sparse thin beds of light-yellowish-gray, fine-grained sandstone. The member is fairly resistant and forms steep slopes and rounded ledges. It is estimated to range in thickness from about 250 to 350 feet (76-107 m) in this quadrangle.

Middle member of the Entrada Sandstone (Jem)— This member is composed of alternating sets of thin beds of reddish-brown, silty fine-grained sandstone and dusky red and light-brownish-gray sandy siltstone and mudstone. The member is less resistant than the underlying or overlying members, but commonly forms a steep slope in the exposures along Pine Creek. It is estimated to range from about 300 to 400 feet (91-122 m) in thickness in this quadrangle.

Upper member of the Entrada Sandstone (Jeu)— This member is composed of light-gray to pale-orange, fine-grained sandstone in trough and planar sets of high-angle crossbeds bounded by flat truncation planes. It is fairly resistant and forms conspicuous light-colored, rounded cliffs north and west of Escalante. The upper member is estimated to range from about 200 to 250 feet (60-75 m) in this quadrangle. The total thickness of the formation ranges from about 750 to 1000 feet (229-305 m) and thickens generally southward.

Upper Jurassic Series

Tidwell Member of the Morrison Formation (Jmt)— The lower member of the Morrison Formation consists of sandstone, mudstone intergrading with siltstone, and minor limestone. The sandstone is light gray and light yellowish gray, fine-grained, and laminated to thin bedded. Mudstone and siltstone is greenish gray and reddish brown. Gray limestone, micrograined but locally recrystallized to coarse grained, is in lenses 1 to 2 feet (.3-.6 m) thick. The basal contact is a regional unconformity (Peterson, Fred, 1980, p. 69-70; 1988, p. 35-42). The member is about 120-140 feet (36-43 m) thick in this quadrangle.

Salt Wash Member of the Morrison Formation (Jmbs)— The upper part of the Morrison Formation in this quadrangle consists mostly of pinkish-gray and yellowish-gray sandstone and conglomerate and grayish-green to dark-reddish-brown mudstone. The sandstone is fine to medium grained and contains rare to abundant pebbles and grades to conglomerate. The pebbles are commonly subrounded, 1/8 to 1/4 inches (.3-.6 cm) in diameter, and are mostly yellowish-gray and tan chert. The sandstone and conglomerate are in fairly persistent ledge-forming sets as much as 40 feet (12 m) thick. The member forms an irregular low to moderate slope. The Salt Wash is about 120-160 feet (37-49 m) thick in the Escalante quadrangle. The map unit (Jmbs) includes the overlying Brushy Basin Member.

Brushy Basin Member of the Morrison Formation— The upper member of the Morrison is a slope-forming unit composed of light- to dark-gray, pale-green, reddish-brown and purple bentonitic mudstone. Sparse lenses of conglomerate are composed of small red, green, gray and black chert pebbles in a matrix of medium-grained sandstone. The member ranges from 0 to about 150 feet (0-46 m) in thickness; the total thickness of the Morrison Formation ranges from about 250 to 450 feet (76-137 m) in this quadrangle.

CRETACEOUS SYSTEM

Upper Cretaceous Series

Dakota Formation (Kd)— The Dakota Formation consists chiefly of interbedded sandstone and shale. The sandstone is light brown, fine- to medium-grained, calcitic, mostly crossbedded, and is in ledge-forming beds, commonly a few feet to several tens of feet thick. It is interstratified with olive-gray to black, slightly to very carbonaceous shale and gray siltstone, and a few beds of coal. Iron-stained impressions of fossil plant material are common in sandstone. In the upper part of the formation the pelecypods *Ostrea* and *Exogyra* are locally abundant in sandstone. Most shale contains flakes of black carbonaceous material and in places grades to very carbonaceous mudstone and thin lenses of coal; these rock types form slopes and are poorly exposed. The upper part of the formation is mostly shale and crops out poorly. At the base of the Dakota is a southward-truncating regional unconformity, commonly marked by channels filled with iron-stained lenses of conglomerate composed chiefly of pebbles and cobbles of chert and quartz. The Lower Cretaceous Cedar Mountain Formation, a light-gray conglomerate composed chiefly of pebbles and cobbles of white to gray quartz and chert in a medium- to coarse-grained sandstone matrix, crops out about 1 mile (1.6 km) west of the quadrangle in lenses as much as 40 feet (12 m) thick (Weir and Beard, 1981b). The Cedar Mountain may be represented in this quadrangle by sporadic lenses, less than 3 feet (.9 m) thick, of light-gray quartz and chert conglomerate at the base of the Dakota. Thickness of the map unit ranges from about 130 to 170 feet (40-52 m).

Tropic Shale (Kt)— A dark-greenish-gray marine shale. Thin, white, bentonite beds are common in the basal 50 feet (15 m). A zone of light-gray limestone concretions containing marine fossils is about 10 feet (3 m) above the base. The formation forms slopes and generally is very poorly exposed. Only about the lower 300 feet (91 m) of the Tropic Shale is present in this quadrangle although the formation is 800 feet (244 m) thick in the adjoining Wide Hollow Reservoir quadrangle (Stevens, 1973).

TERTIARY(?) AND QUATERNARY SYSTEMS

Pliocene(?) and Pleistocene Series

High volcanic-gravel terrace alluvium (QTatv)— Volcanic-gravel terrace alluvium is composed mainly of rounded cobbles and boulders, as much as 6 feet (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 resistant sandstone from local bedrock formations. Yellow-brown, red, and orange chert in irregular blocks and small rounded pebbles of black chert are sparse but locally conspicuous. The deposits are generally poorly consolidated; they are irregularly cemented with calcite. Many boulders and cobbles are coated in whole or part with white to light-yellowish-grey pedogenic calcium carbonate.

Bedding is generally obscure, but a few exposures display crudely graded beds and trough sets of crossbeds in channel fills. The deposits are veneered irregularly by wind-blown sand. The high volcanic-gravel terrace alluvium is a stream deposit, probably derived from debris slides and flows that issued from the Aquarius Plateau, north of this quadrangle (Williams, 1985). Only a few remnants, less than 30 feet (9 m) thicks, of the high-level volcanic alluvium are in the Escalante quadrangle. They lie on the Navajo Sandstone near the junction of Pine Creek and the Escalante River and on the Morrison Formation northwest of Escalante. The deposits rest on an erosion surface about 400 to 430 feet (122-131 m) above stream level that predates the cutting of the Escalante River canyon.

QUATERNARY SYSTEM

Pleistocene Series

Intermediate volcanic-gravel terrace alluvium (Qat_5, Qat_4)— These deposits are lithologically similar to the high volcanic-gravel described above. Generally, they are less indurated and lack coatings of calcium carbonate. The intermediate volcanic-gravel occurs in a few small remnants, probably as much as 30 feet (9 m) thick, resting on the Navajo Sandstone along Pine and Sand Creeks. The older part (Qat_5) of these deposits lies about 260 feet (79 m) above stream level; the younger deposits (Qat_4) lie about 180 feet (55 m) above stream level.

Pleistocene and Holocene(?) Series

Low quartzite- and volcanic-gravel terrace alluvium (Qat_3, Qat_2)— These deposits are similar to the intermediate volcanic-gravel allulvium, but they also contain sparse to abundant pebbles and cobbles of quartzite, quartz, and fine-grained metamorphic rocks, all derived from Cretaceous or Tertiary formations north of the quadrangle, and admixtures of local bedrock. These deposits along Pine Creek and in the southwest corner of the quadrangle are as much as 30 feet (9 m) thick. The Pleistocene terrace alluvium (Qat_3) lies about 60 feet (18 m) above stream level; the Holocene(?) alluvium (Qat_2) lies about 40 feet (12 m) above stream level.

Debris-slide colluvium (Qms)— This deposit is composed mostly of dark-gray and dark-brown subangular to rounded boulders, as much as 6 feet (2 m) across, of basaltic andesite in a sandy to clayey matrix. It includes a few subangular blocks of sandstone and irregular masses of shale at the base. The deposit was formed by sliding of part of the Tropic Shale that was overlain by high volcanic-gravel terrace alluvium in the Black Hills west of Pine Creek. The deposit is estimated to be as much as 200 feet (61 m) thick.

Block-slide deposits (Qmb)— In the southern part of the Black Hills are deposits consisting of fairly intact, large slide blocks of the Dakota Formation. Undistorted bedding in the blocks has been rotated back to dip steeply (as much as 50°) toward the source cliffs a short distance away. The long axes of the slide deposits are parallel to the topographic contours. The block masses are as much as 1500 feet (457 m) long, 300 feet (91 m) wide, and 60 feet (18 m) thick.

Pleistocene(?) and Holocene Series

Volcanic-boulder colluvium (Qcv)— This material consists chiefly of rounded boulders, as much as 3 feet (.9 m) across, of basaltic andesite in a sandy to clayey matrix. The colluvium was derived from erosion of the debris-slide colluvium of the Black Hills and high volcanic-gravel allulvium on the east side of Pine Creek, and moved downslope by creep, rolling, and sliding. The deposits lie on the Dakota Sandstone and Jurassic formations on the west side of Pine Creek and on the Navajo Sandstone on the east side of the creek. The larger deposits bordering the Black Hills probably attain a thickness of about 100 feet (30 m).

Fan alluvium (Qaf)— These deposits are yellowish-gray to dark-reddish-brown silt and sand and sparse to abundant pebbles, cobbles, and boulders derived from local bedrock and surficial deposits. Stratification is obscure but in part is laminae and thin beds and lenses of low-angle cross laminae. The material has been deposited by streams and sheetwash in fan-shaped bodies, as much as 60 feet (18 m) thick, at the mouth of stream valleys, mostly in the southwestern part of the quadrangle.

Holocene Series

Sandstone talus (Qmts)— These small deposits of rockfall colluvium are angular blocks of light-grayish-orange and reddish-gray sandstone and sand that have accumulated at the angle of repose on steep slopes below cliffs of Navajo Sandstone, chiefly along the Escalante River, the upper reaches of Death Hollow, the west side of Pine Creek, and below cliffs of the Salt Wash Member of the Morrison Formation northwest of Escalante. Maximum thickness of the rockfall colluvium is probably about 25 feet (8 m).

Sandstone-boulder colluvium (Qcs)— These deposits consist of subangular clasts, as large as 10 feet (3 m) across, of broken, limy sandstone from the Dakota Formation and lesser amounts of multicolored chert-pebble conglomerate from the Salt Wash Member of the Morrison Formation, generally with a matrix of sand and chert pebbles. The deposits, which occur only in the Black Hills in the western part of the area, are a lag deposit from erosion of beds of conglomerate. They probably are as much as 50 feet (15 m) thick.

Fine-grained terrace alluvium (Qat_1)— These low-level terrace deposits are medium-gray to grayish-orange-pink silt and sand and local gravel in laminae, ripple laminae, graded beds and trough crossbeds. The deposits form much of the valley floor around Escalante and cover a few small benches along Pine Creek. They are estimated to be as much as 50 feet (15 m) thick.

Floodplain alluvium (Qal)— Alluvium on modern floodplains and in narrow channels in this quadrangle consists of yellowish-gray to grayish-orange-pink fine sand and silt with variable admixures of pebbles to boulders of basaltic andesite, basalt, quartzite and sandstone. Ripple laminations, trough crossbedding, graded bedding, and imbricated gravels occur locally in these deposits, which are probably as much as 15 feet (5 m) thick along the Escalante River, Pine Creek, and Death Hollow. The mapped alluvium includes a few areas of fine-grained terrace alluvium and low gravel terrace alluvium too small to show separately.

Sheetwash alluvium and eolium (Qae)— These deposits, formed by water flowing in sheets and shallow channels and modified by wind, consist of yellowish-brown to dark-reddish-brown and grayish-orange-pink silt, sand, and small rock fragments. They locally contain and intergrade with wind-blown sand. They cover much of the valley flats near Escalante and part of Antone Flat near the center of the quadrangle. These deposits are probably not more than 10 feet (3 m) thick.

Sandy residuum (Qrs)— In the northwest corner of the quadrangle the Navajo Sandstone is exposed on a nearly flat surface and has weathered to produce a residuum, about 3 feet (.9 m) thick, of yellowish-gray to grayish-orange-pink sand and unsorted, locally iron-impregnated, angular fragments of sandstone. The deposit is veneered locally with wind-blown sand. Similar thin patches of residuum, too small to show at this map scale, occur widely on relatively flat outcrops of the Navajo.

Wind-blown sand (Qes)— The eolian deposits are composed of unconsolidated yellowish-gray to pale-red, fine grains of quartz and minor silt, derived mainly from the Navajo and Page Sandstones on which most of the deposits rest. Bedding is generally obscure, but in part the sand is in small-scale trough and planar sets of crossbeds. The sand forms many broad, thin sheets on the relatively flat upland areas in the eastern two-thirds of the quadrangle. The maximum thickness of these deposits is estimated to be about 12 feet (4 m).

Artifical fill (Qfh, Qfl)— Unsorted boulder to pebble gravel mixed with sand and silt has been quarried locally from the Entrada Sandstone, Carmel Formation, and alluvium and colluvium. The material has been used as highway fill (Qfh) and for stock-pond dams and landfills (Qfl).

STRUCTURAL GEOLOGY

The major structure of the Escalante quadrangle is the asymmetric Escalante anticline, whose gently southeast-plunging axis crosses the quadrangle from near the northwest corner to near the middle of the south edge. Dips on the east flank are relatively gentle, mostly from 3° to 8°. The west flank is much steeper with dips as much as 40°, and has been referred to as the Escalante monocline (Stephens, 1973; Weir and Beard 1981a, b). The Black Hills in the western part of the quadrangle contain a poorly defined shallow northwest-plunging, syncline. The southeast corner of the quadrangle contains part of the broad gently south-plunging Slickrock Saddle syncline. This syncline was included in a broad regional structure called the Sand Creek syncline by Hackman and Wyant (1973, sheet 2).

The Navajo Sandstone, which crops out over much of the quadrangle, is cut by many vertical and near-vertical joints. The joints for the most part are closely spaced and, although locally obscure, are generally conspicuous because they control many small topographic forms. Not all joints are shown on the map; the symbols indicate representative, well-defined sets of joints. The joint pattern is in places complex, but northwesterly trends are most common.

ECONOMIC GEOLOGY

Geochemical reconnaissance, which included the eastern part of the quadrangle as well as adjoining areas in the north, east, and south, did not indicate the presence of mineralized terranes in the Escalante quadrangle (Weir and Lane, 1981a, b, 1983).

The only known mineral deposit is the Van Hamet manganese prospect in sec. 24, R. 3 E., T. 35 S. (projected) near the south edge of the quadrangle. The deposit consists of purplish-black manganese minerals in irregular nodular concretions, as much as 6 inches (15 cm) across, in reddish-brown, fine-grained sandstone in the Judd Hollow Tongue of the Carmel Formation. The mineralized material is scattered through layers less than a foot thick in a sandstone lens, about 6 feet (2 m) thick, and makes up less than 5 percent of the host rock. It lies within an area less than 200 feet (60 m) in diameter. Samples of the mineralized rock collected by Doelling (1975, p. 138) ranged from about 16 to 27 percent manganese and from 45 to 54 percent silica. The deposit appears to be too small to yield ore in commercial quantities. Furthermore, geologically similar deposits elsewhere in western Utah have not proved economical (Crittenden, 1951, p. 14). Thus, the manganese potential of the quadrangle is negligible.

Small, low-grade uranium-copper deposits are in Triassic formations in the Circle Cliffs about 15 miles (24 km) east of the quadrangle (Davidson, 1967, p. 65-91; Doelling, 1975, p. 107-109, 131-135). The same Triassic formations underlie the Escalante quadrangle at depths of several thousand feet and may contain similar deposits, but the potential host rocks are unlikely to warrant exploration. Gypsum occurs in small lenses in the Carmel Formation, but potentially economic thicker beds are known elsewhere in Garfield County (Doelling 1975, p. 146-149).

Road material has been quarried on a small scale near the quadrangle from Quaternary surficial deposits consisting mainly of volcanic rocks and quartzite and from siltstone, shale, and sandstone of the lower part of the Carmel Formation. None of this material has been trucked more than a few miles.

Of interest to mineral collectors are fragments of brightly colored chert, probably derived from volcanic deposits on the Aquarius Plateau, that occur in surficial deposits composed mainly of volcanic rocks. Fragments of dinosaur bone from the Morrison Formation and petrified wood from Cretaceous strata also occur in some surficial deposits. All these materials are sparse and erratically distributed.

The oil and gas potential of the area has not been adequately tested (Brandt, 1987). Oil is produced from Triassic and Permian strata in a fold, similar to the Escalante anticline, in the Upper Valley field about 10 miles (16 km) southwest of the Escalante quadrangle (Peterson, 1973). The Escalante anticline was tested in the south-central part of this quadrangle by the Gulf Oil Co. No. 1 Garfield-X well in 1972. The well penetrated Triassic and Permian rocks and bottomed in the Cedar Mesa Sandstone Member of the Cutler Formation (Permian) at a depth of 4399 feet (1341 m) with no recorded show of oil or gas. Six other tests of Triassic and Permian strata drilled 8 to 10 miles (13-16 km) north of the area on the Escalante anticline did not produce oil or gas, although several shows of hydrocarbons were noted in Triassic and Permian rocks. However, all the wells had flows of nonflammable gas and two of the wells were completed for production of CO_2 gas (Heylmun and others, 1965, p. 68-69; Brandt, 1987; unpublished well records of the Utah Geological and Mineral Survey and the Bureau of Land Management, Salt Lake City, Utah).

Thin, lensing beds of coal occur near the middle of the poorly exposed Dakota Formation in the Black Hills and in outcrops in the southwest corner of the quadrangle. These beds are unlikely to be developed because large reserves of coal in thick beds are in the Kaiparowits basin, a few miles west of Escalante (Doelling, 1975, p. 68-78).

Water for domestic and agricultural purposes for Escalante and vicinity is supplied by diversions from the Escalante River and Pine Creek. Reserves of ground water in the lower part of the Entrada Sandstone and in the Navajo Sandstone are thought to be substantial (Goode, 1969).

A major natural resource in the quadrangle is the magnificent canyon and rock-monument scenery created by the erosion of the Escalante anticline (Carter and Sargent, 1983). Many hikers traverse the desert and riverside trails that end or begin near Escalante (U.S. Bureau of Land Management, 1979; Lambrechtse, 1985).

GEOLOGIC HAZARDS

Floods are the chief natural hazard in the Escalante quadrangle. Summertime cloudbursts in the northern part of the quadrangle or adjacent areas can result in flash floods suddenly coursing down narrow canyons. In addition, temporary dams formed by rockfalls may give way to release an unexpected torrent downstream. Hikers in the cliff-and-canyon topography in the eastern part of the quadrangle should also beware of possible rock falls as well as flash floods.

Care should be taken for any construction on surficial deposits. Alluvial and eolian sand (Qae, Qes) may be unstable even on moderate slopes. Debris-slide colluvium and shale and mudstone in the Dakota Sandstone and Tropic Shale and in the upper part of the Morrison Formaiton, all in the Black Hills, are potentially unstable, especially during rainy periods. Planning for construction in this area should take this danger into account.

Seismic risks in the quadrangle appear small. Only two earthquakes of magnitude 4.0 or greater in eastern Garfield County have been recorded in historic time (Ward, 1979, fig. 1). Faults in this quadrangle and in adjacent quadrangles show no evidence of geologically recent movement. The Escalante quadrangle lies in relatively low seismic zones U-1 and U-2, on a scale of 1 to 4, of the Utah Uniform Building Code (Ward, 1979, fig. 3). Earthquakes transmitted from tectonically more active regions, however, may result in rockfalls or sliding of slope deposits.

REFERENCES CITED

Brandt, Cynthia, 1987, The oil and gas potential of the Escalante known geologic structure: Utah Geological and Mineral Survey Open-File Report 102, 6 p., 8 figs.

Carter, L.M.H., and Sargent, K.A., 1983, Map showing geology-related scenic features in the Kaiparowits Plateau area, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I-1033-K, scale 1:125,000.

Crittenden, M.D., 1951, Manganese deposits of western Utah: U.S. Geological Survey Bulletin 979-S, 62 p.

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

Detterman, J.S., 1955, Photogeologic map of the Kaiparowits Peak-8 quadrangle, Garfield County, Utah: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-14, scale 1:24,000.

Doelling, H.H., 1975, Geology and mineral resources of Garfield County, Utah: Utah Geological and Mineral Survey Bulletin 107, 175 p., scale 1:250,000.

Goode, H.D., 1969, Reconnaissance appraisals of the water resources near Escalante, Garfield County, Utah: Utah Geological and Mineralogical Survey Water-Resources Bulletin, 11, 38 p.

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., 1956, The geology of the Escalante-Boulder area, Garfield County, Utah: New Haven, Conn., Yale University, unpub. Ph.D. thesis, 180 p.

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

Peterson, Fred, 1980, Sedimentology as a strategy for uranium exploration: Concepts gained from analysis of a uranium-bearing depositional sequence in the Morrison Formation of south-central Utah, *in* Turner-Peterson, C.E., editor, Uranium in Sedimentary Rocks: Applications of the Facies Concept to Exploration: Denver, Colorado, Society of Economic Paleontologists and Mineralogists, The Rocky Mountain Section, p. 65-126.

———1988, Stratigraphy and nomenclature of Middle and Upper Jurassic rocks, western Colorado Plateau, Utah and Arizona: U.S. Geological Survey Bulletin 1633-B, p. 13-56.

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 Mineralogical Survey Oil and 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 1:125,000.

Stephens, E.V., 1973, Geologic map and coal resources of the Wide Hollow Reservoir quadrangle, Garfield County, Utah: U.S. Geological Survey Coal Investigations Map C-55, scale 1:24,000, 2 sheets.

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

Thompson, A.E., and Stokes, W.L., 1970, Stratigraphy of the San Rafael Group, southwest and south-central Utah: Utah Geological and Mineralogoical Survey Bulletin 87, 53 p.

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., 1981a, Geologic map of the Phipps-Death Hollow Instant Study Area, Garfield County, Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-1314, scale 1:48:000.

———1981b, Geologic map of The Box-Death Hollow Further Planning Area (RARE II), Garfield County, Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-1319-A, scale 1:48,000.

Weir, G.W. and Lane, M.E., 1981a, Mineral resource potential 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 Investigation Series Map I-1033-L, scale 1:125,000.