

DESCRIPTION OF FREDONIA 1:24,000-SCALE MAP UNITS

[The following 11 individual map units are shown only on 1:24,000-scale views; these units are either grouped or renamed on the 1:100,000-scale map. A complete description of map units for both 1:24,000- and 1:100,000-scale is included in the pamphlet that accompanies Scientific Investigations Map SIM.]

SURFICIAL DEPOSITS

- Qes Eolian sand sheet deposits (Holocene)**—On Moccasin Mountains and Paria Plateau above Vermilion Cliffs; light-red to white silt and fine- to coarse-grained eolian sand derived from the Navajo Sandstone (Jn). Only most extensive and thickest deposits are shown. Gradational contacts between eolian sand sheet (Qes), dune sand and sand sheet (Qd) deposits, and young mixed alluvium and eolian (Qae) deposits based on geomorphologic interpretation on aerial photos. Below Vermilion Cliffs, deposits accumulate along local stream drainages and on gentle slopes of young and intermediate alluvial fan (Qa1, Qa2) deposits. Deposit often leads to fine-grained climbing or falling dunes of dune sand and sand sheet (Qd) accumulations on steep topography along base of Vermilion Cliffs and on west side of Paria Plateau. In Pipe Valley south of State Highway 389 and in House Rock Valley along U.S. Highway 89A; white to light-brown and light red fine- to coarse-grained quartz sand partly stabilized by grass and small high-desert shrubs during wet conditions. Adjacent young alluvial fan (Qa1) and colluvial (Qc) deposits are partially stabilized by lag gravel pavement surfaces consisting mostly of black well-rounded pebbles derived from the Shinarump Member of the Chinle Formation south and west of Yellowstone Mesa. Support moderate growths of grass, black brush, and other small high-desert shrubs above Vermilion Cliffs and mostly grass below Vermilion Cliffs. About 1 to 2 m (0.5 to 6 ft) thick near and below Vermilion Cliffs; about 3 to 6 m (9 to 20 ft) thick on Moccasin Mountains and Paria Plateau. [Qd on 1:100,000-scale map]
- Qg1 Young terrace-gravel deposits (Holocene)**—Below Vermilion Cliffs; consists of red, white, and gray interbedded fine- to coarse-grained sand and thinly laminated silt; partly consolidated by clay and calcite cement. Include interbedded thin beds of gray or red mud and clay and interbedded lenses of gravel composed of gray subangular chert fragments. Unit cut by modern erosion as much as 9 m (30 ft) in Kanab Creek near Fredonia and Vermilion Cliffs.
- On Kanab Plateau, Uinkaret Plateau, and Kanab Canyon areas; consists of gray and light-brown, fine- to coarse-grained silt, sand, and gravel; partly consolidated by gypsum and calcite cement. Include gray-blue subrounded limestone and light-red sandstone clasts, in matrix of mostly white angular and subangular chert gravel. Deposits commonly inset against intermediate terrace-gravel (Qg2) deposits and young and intermediate alluvial fan (Qa1, Qa2) deposits. Subject to flash flood erosion or overbank accumulation of flood-plain (Qf) sediments in upper Kanab Creek drainage and its northeastern tributaries in Muggins Flat, north-central part of map area. Support moderate growths of sagebrush, grass, cactus, tamarisk trees, willow trees, juniper and pinyon at elevations above 1,525 m (5,000 ft); mostly vegetated by grass, thick growths of cactus, sagebrush and desert shrubs below 1,525 m (5,000 ft). Terraces are generally 1 to 3 m (3 to 10 ft) above stream-channel (Qs) deposits. Unit often cut by arroyo erosion as much as 6 m (20 ft) in south-central part of map. Thickness, 1 to 15 m (4 to 50 ft) or more. [Qgy on 1:100,000-scale map]

Qa1 Young alluvial fan deposits (Holocene)—Vermilion Cliffs area; consists of light-red and brown silt and fine- to coarse-grained sand and gravel; partly consolidated by calcite and clay. Include subangular red and white chert fragments and small red and white sandstone and gray limestone clasts generally less than 5 cm (2 in) in diameter derived locally from nearby Vermilion Cliffs. Include large boulders of the Shinarump Member of the Chinle Formation as much as 2 m (6 ft) in diameter below Yellowstone Mesa area. Clay content greatest below or in outcrops of Petrified Forest Member of the Chinle Formation. Include numerous black, brown, yellow, red, and gray, very well rounded quartzite and chert pebbles 1.5 to 5 cm (0.5 to 2 in) in diameter and occasional rounded, gray-white petrified wood fragments down slope of Vermilion Cliffs areas. Locally covered by thin eolian sand sheet (**Qes**), young mixed alluvium and eolian (**Qae**) deposits, or dune sand and sand sheet (**Qd**) deposits at distal ends of alluvial fan deposits.

On Kanab Plateau, Uinkaret Plateau, and in Kanab Creek drainages; gray, light-red, and light-brown silt, sand, and white cherty gravel, partly consolidated by gypsum and calcite. Include lobes of flash flood debris flows of unsorted angular boulders in sandy matrix that often form temporary dams that block principal drainages, primarily in Kanab Creek, Nail Canyon, and Snake Gulch, central part of map area. Overlap or intertongue with stream channel (**Qs**) deposits in upper Kanab Creek drainages and Muggins Flat area. Subject to extensive sheet wash erosion or sediment accumulation during heavy storms. Support moderate growths of grass, sagebrush, and various small high-desert shrubs. Thickness, 2 to 12 m (6 to 40 ft). [**Qay** on 1:100,000-scale map]

Qg2 Intermediate terrace-gravel deposits (Holocene and Pleistocene(?))—Gray, light-red to brown, thin- to massive-bedded, interbedded clay, poorly sorted silt, and fine- to coarse-grained sand similar to young terrace-gravel (**Qg1**) deposits; partly consolidated by clay and gypsum. Overlap or intertongue with young and intermediate alluvial fan (**Qa1**, **Qa2**), valley-fill (**Qv**) or young mixed alluvium and eolian (**Qae**) deposits. Form terraces generally 2.5 to 9 m (8 to 30 ft) above local streambeds and as much as 18 m (60 ft) above stream channels in upper reaches of Kanab Creek and some of its tributaries. Often cut by arroyos as much as 11 m (35 ft) deep adjacent to Kanab Creek and some tributaries of Kanab Creek. Support moderate growths of grass, cactus, black brush, sagebrush, juniper and pinyon above 1,525 m (5,000 ft) elevation; abundant grass, cactus, oak, and some cottonwood trees in lower reaches of Kanab Creek. Thickness, 2.5 to 18 m (8 to 60 ft). [**Qgy** on 1:100,000-scale map]

Qa2 Intermediate alluvial fan deposits (Holocene and Pleistocene(?))—Similar in composition to young alluvial fan (**Qa1**) deposits but surfaces are generally gullied as much as 3 m (10 ft) or partly covered by desert pavement of small gravel or pebbles in northwest quarter of map area. Partly consolidated by calcite, clay, and gypsum cement below stratigraphic level of the Chinle Formation; mostly unconsolidated above Chinle Formation below Vermilion Cliffs. Commonly overlapped by young alluvial fan (**Qa1**), flood-plain (**Qf**), or stream-channel (**Qs**) deposits. Intertongue with intermediate terrace-gravel (**Qg2**) deposits near distal ends of fans. Intertongue with landslide (**Ql**) and talus and rock fall (**Qtr**) deposits at upper reaches of alluvial fans below Vermilion Cliffs where unit is heavily dissected by erosion. Support moderate growths of sagebrush, cactus, and grass below 1,525 m (5,000 ft) elevation and moderate oak, juniper, pinyon, and ponderosa woodlands above 1,525 m (5,000 ft). Thickness, 2 to 18 m (6 to 60 ft). [**Qay** on 1:100,000-scale map]

- Qg3 Old terrace-gravel deposits (Holocene and Pleistocene(?))**—Gray, light-brown to light-red clay, silt, and sand; partly consolidated by calcite and gypsum cement in Kanab Creek tributaries. Locally contain lenses of small rounded to subrounded pebble gravel and conglomerate composed of white and red sandstone, blue-gray limestone, abundant subrounded or angular white chert, and scattered, well rounded, multicolored quartzite pebbles in fine- to coarse-grained gravel matrix. Downslope of Vermilion Cliffs, include well rounded quartz, chert, or quartzite pebbles of various sizes derived from Shinarump Member of the Chinle Formation. In eastern tributaries of Kanab Creek and Muggins Flat west of Kaibab Plateau, include occasional well-rounded pebbles and small cobbles of brown, purple, and gray quartzite clasts derived from old gravel and sedimentary (Ts1) deposits. Unit forms terraces about 9 to 37 m (30 to 120 ft) above stream channel (Qs) deposits along Kanab Creek and its tributaries; often covered by thin eolian sand sheet deposits or lag gravel deposits too thin to show at map scale. Support sparse growths of sagebrush, black brush, cactus, and grass. Thickness, 2 to 6 m (6 to 20 ft). [Qgo on 1:100,000-scale map]
- Qa3 Old alluvial fan deposits (Holocene and Pleistocene(?))**—Red, gray, and brown mud, silt, sand, and gravel, poorly sorted; partly consolidated by calcite and gypsum cement. Stony surface where not covered by dune sand and sand sheet (Qd) deposits along base of Vermilion Cliffs; surface often exhibits desert pavement composed mainly of black, well rounded pebbles in northwest quarter of map area. Unit is extensively eroded and contributes material to young and intermediate alluvial fan deposits. Intertongue with talus and rock fall (Qtr) and landslide (Ql) deposits. Adjacent to or overlapped by young and intermediate alluvial fan (Qa1, Qa2), eolian sand sheet (Qes), and dune sand and sand sheet (Qd) deposits. Thickness, 3 to 15 (10 to 50 ft). [Qao on 1:100,000-scale map]
- Qa4 Older alluvial fan deposits (Pleistocene and Pliocene(?))**—Gray, brown, poorly sorted mixture of silt, sand, gravel and angular to subrounded fragments of chert, limestone, and sandstone derived from the Kaibab Formation on west side of Kaibab Plateau and from the Hermit Formation, Coconino Sandstone, Toroweap Formation, and Kaibab Formation on east side of Kaibab Plateau. Include scattered, well rounded, brown, black, gray, and purple quartzite pebbles and cobbles derived from old stream-channel (Ts) deposits; include lag gravel from old stream-channel deposits on northwest and east slope of Kaibab Plateau area. Form elevated and isolated alluvial fans that overlie bedrock of the Moenkopi Formation or Kaibab Formation. About 9 to 37 m (30 to 120 ft) above young, intermediate, and old alluvial fan (Qa1, Qa2, Qa3,) deposits in north-central part of map area. Surface consolidated by calcite and gypsum cement forming a rocky calcrete soil zone 0.5 to 1.2 m (2 to 4 ft) thick; extensively gullied and eroded near fan edges. Cobbles and boulders on fan surface are commonly encased in calcite rinds and caliche detritus material. Support pinyon, juniper, and oak woodlands with grass, cactus, and sagebrush. Thickness, 1.5 to 9 m (5 to 30 ft). [Qao on 1:100,000-scale map]
- Jmd Dinosaur Canyon Member of the Moenave Formation (Lower Jurassic)**—Reddish-brown, slope and ledge-forming, thin-bedded, very fine-grained sandstone and silty sandstone. Gradational contact with underlying Whitmore Point Member of the Moenave Formation west of Fredonia; marked by distinct color contrast between blue-green, green, and yellow mudstone and siltstone of Whitmore Point Member to reddish-brown siltstone and sandstone of Dinosaur Canyon Member; unconformable contact with Owl Rock Member of the Chinle Formation in House Rock Valley area where Whitmore Point Member is missing. Unit

commonly covered by landslide (Ql) and talus and rock fall (Qtr) deposits. Thickness ranges from about 37 to 60 m (120 to 200 ft). [Jm on 1:100,000-scale map]

Jmw **Whitmore Point Member of the Moenave Formation (Lower Jurassic)**—Type section is at Radio Towers near Potter Canyon, southwest of Moccasin Mountains (elev. 2,013 m [6,603 ft]). Named for Whitmore Point by Wilson (1967), the name Whitmore Point is not on 1988 USGS 7.5' Moccasin quadrangle. Composed of reddish-brown sandstone and siltstone interbedded with reddish-purple to greenish-gray and blue mudstone and claystone, and thin gray dolomitic limestone. Limestone contains small reddish-brown chert nodules and poorly preserved fossil algal structures and fish scales and bones near Zion National Park north of map area (Biek and others, 2000; 2007). Unconformable contact with underlying Chinle Formation in west half of map area; unit thins eastward to less than 12 m (40 ft) at Vermilion Cliffs on east side of House Rock Valley, northeast quarter of map area. Thickness ranges from about 12 to 24 m (40 to 80 ft). [Jm on 1:100,000-scale map]