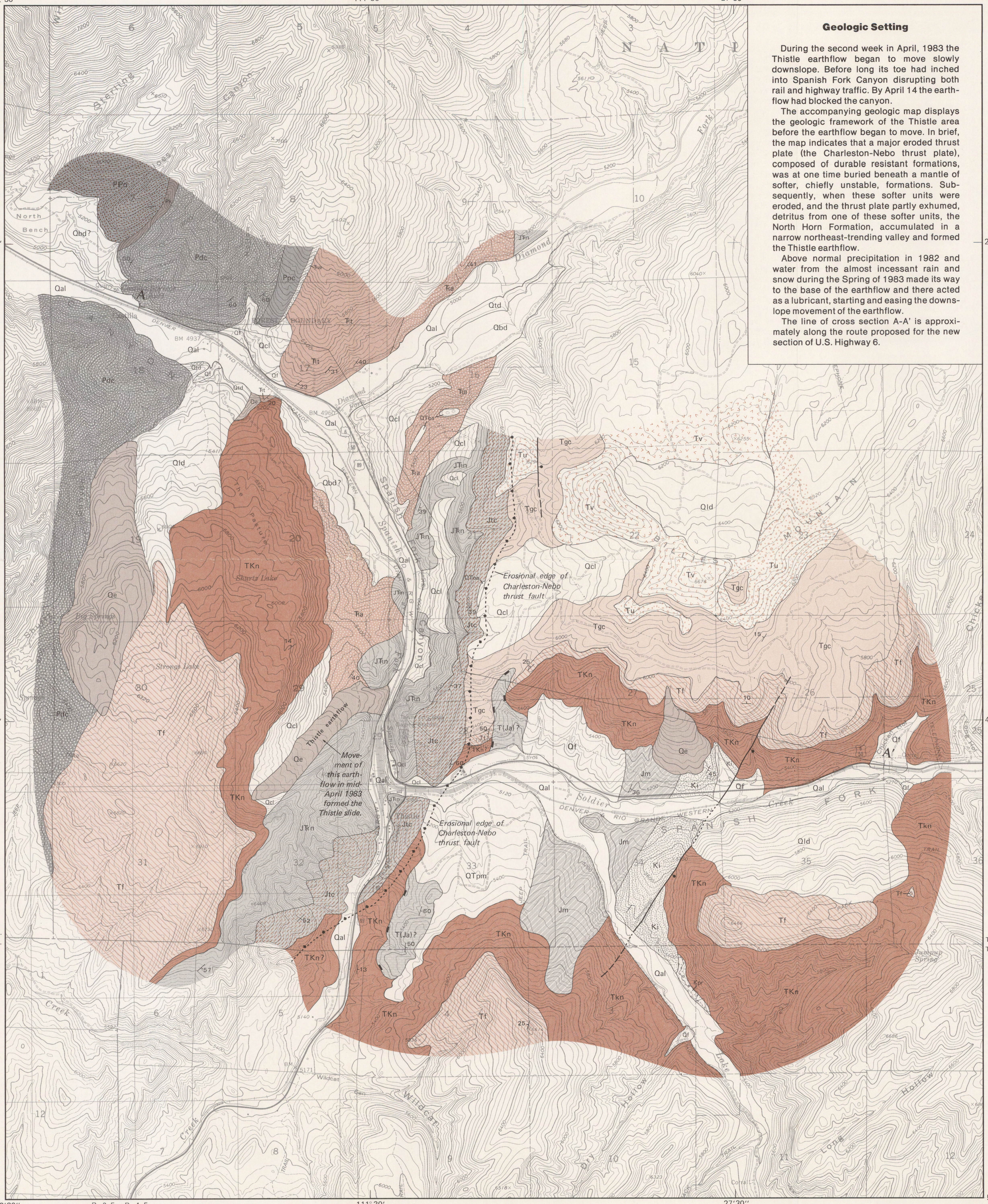
STATE OF UTAH
DEPARTMENT OF NATURAL RESOURCES
UTAH GEOLOGICAL AND MINERAL SURVEY



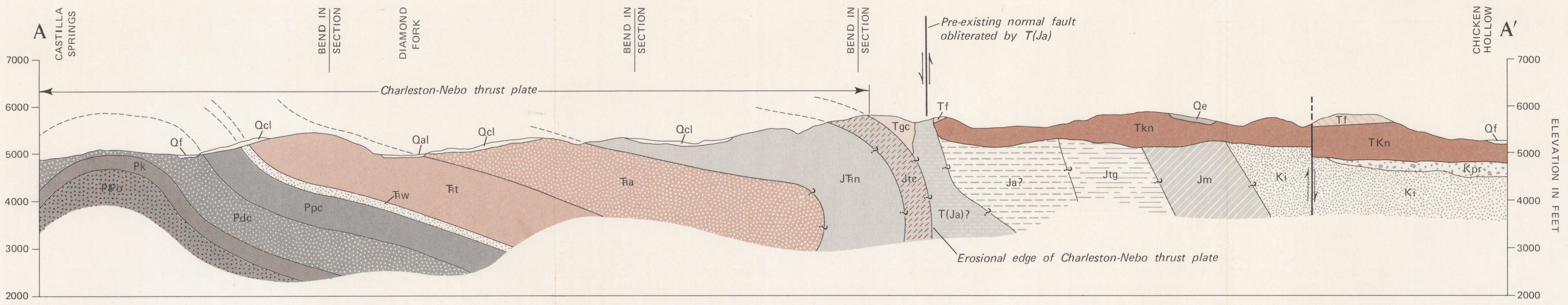
Geologic Setting

During the second week in April, 1983 the Thistle earthflow began to move slowly downslope. Before long its toe had inched into Spanish Fork Canyon disrupting both rail and highway traffic. By April 14 the earthflow had blocked the canyon.

The accompanying geologic map displays the geologic framework of the Thistle area before the earthflow began to move. In brief, the map indicates that a major eroded thrust plate (the Charleston-Nebo thrust plate), composed of durable resistant formations, was at one time buried beneath a mantle of softer, chiefly unstable, formations. Subsequently, when these softer units were eroded, and the thrust plate partly exhumed, detritus from one of these softer units, the North Horn Formation, accumulated in a narrow northeast-trending valley and formed the Thistle earthflow.

Above normal precipitation in 1982 and water from the almost incessant rain and snow during the Spring of 1983 made its way to the base of the earthflow and there acted as a lubricant, starting and easing the downslope movement of the earthflow.

The line of cross section A-A' is approximately along the route proposed for the new section of U.S. Highway 6.



Base from U.S. Geological Survey topographic quadrangles: Spanish Fork Peak, 1949; Billies Mtn., 1967; Santaquin Peak, 1952; and Thistle, 1967.

Mapped in May 1983. Based in part on geologic maps prepared by Baker (1972, 1976), Harris (1954), Pinnell (1972), and Young (1976).

SCALE 1:24 000

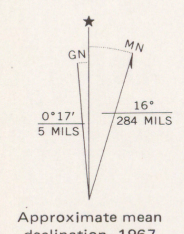
1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

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

Appropriations No. 016103
Archival Approval No. 1830115

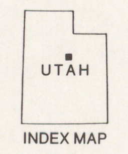


Approximate mean declination, 1967

MAP 69 — MISCELLANEOUS SERIES
GEOLOGIC MAP OF THE THISTLE AREA
UTAH COUNTY, UTAH
June 1983

By Irving J. Witkind and William R. Page, U.S. Geological Survey

Klaus D. Gurgel, Cartographic Editor
B. R. Jones and J. W. Parker, Cartographers



INDEX MAP

Published and sold by
UTAH GEOLOGICAL AND MINERAL SURVEY
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606 Black Hawk Way
Salt Lake City, Utah 84108

EXPLANATION

Quaternary: Qld, Qe, Qtd, QToa, Qcl, Qbd, Qal, Qf, QTvf, QTpm (Holocene — Pleistocene — Pliocene)

Qal, ALLUVIUM — *Unconsolidated deposit of moderately well-sorted clay, silt, sand, granules, pebbles, cobbles, and boulders; thin to thick bedded; crossbedded. Locally unstable on steep slopes. Thickness uncertain; probably does not exceed 75 ft (25 m).*

Qld, OLD LANDSLIDE DEPOSITS — *Accumulation of many large and small masses of unstable bedrock that have moved downslope to form chaotic jumble that masks underlying bedrock. In places, blocks are unbroken and have moved as entities; elsewhere, they are fragmented and form small slump masses. Potentially a very unstable unit. Commonly formed on slopes of the North Horn Formation. Thickness ranges greatly; possible as much as 300 ft (90 m) thick.*

Qe, EARTHFLOW DEPOSIT — *Slump blocks of various sizes and shapes that have moved downslope to form lobate, hummocky mass. Locally occupies former valley. Most abundant near unstable units such as the North Horn and Colton Formations. Very unstable. Deposit commonly moved as an entity; movement of one such earthflow — the Thistle earthflow — in mid-April, 1983 created the Thistle slide. Thickness ranges greatly; as much as 300 ft (90 m) thick locally.*

Qcl, COLLUVIUM — *Heterogeneous mixture of unsorted materials of various sizes and shapes formed at the base of steep slopes by slope wash and mass wasting. Massive. Locally unstable when wet. Thickness ranges widely; probably does not exceed 100 ft (30 m).*

Qf, ALLUVIAL FAN DEPOSIT — *Heterogeneous mixture of unconsolidated silt, sand, granules, pebbles, cobbles, and boulders in a clayey matrix. Derived from units exposed on adjacent slopes. Thin to medium bedded, locally massive; crossbedded. Distinctive fan-shaped fluvial deposit formed at mouth of stream. Locally unstable on steep slopes when wet. In places, several adjacent fans interfinger and coalesce to form broad gently sloping aprons. Thickness ranges greatly; probably does not exceed 100 ft (30 m).*

Qtd, TERRACE DEPOSIT — *Brown to dark-brown unconsolidated beds of silt, sand, granules, and gravel. Thin to medium bedded. Locally crossbedded. Moderately well sorted. Deposited on dissected benches along Spanish Fork and Diamond Fork Rivers. Unstable on steep slopes when wet. Ranges in thickness from 50 to 75 ft (15 to 25 m).*

Qtvf, VALLEY FILL — *Light-brown to brown beds of unconsolidated clay, silt, sand, granules, pebbles, and gravel. Beds of finer and coarser materials alternate irregularly. Thick bedded to massive. Locally unstable when wet. Thickness uncertain, but at least 150 ft (45 m) thick.*

QTpm, PEDIMENT MANTLE — *Light-brown to brown, locally reddish-brown unconsolidated to semi-consolidated mantle of silt, sand, and gravel. Massive to crudely bedded. Consists of mixture of debris derived from adjacent uplands. Surfaces slope gently away from uplands. Moderately stable. Thickness uncertain but probably does not exceed 50 ft (10 m).*

Qbd, DEPOSIT OF ANCESTRAL LAKE BONNEVILLE(?) — *Elongate, even-surfaced, bench-like deposit of unconsolidated beds of sand and locally gravel. Sand is light brown, fine to coarse, and contains small amounts of clay. Likely represents remnant of ancestral beach formed by Pleistocene Lake Bonneville. Locally unstable when wet. About 120 ft (35 m) thick.*

Qtoa, OLDER ALLUVIUM — *Light-gray to light-brown conglomerate and conglomeratic sandstone; commonly well cemented by calcium carbonate. Massive. Forms isolated, discontinuous outcrops along ridge crests and valley flanks. Probably represents remnants of ancient alluvial fill that was cemented. Subsequent erosion has resulted in inversion of topography. Very stable unit. Thickness differs from place to place, but probably does not exceed 75 ft (25 m).*

UNCONFORMITY
Many local unconformities throughout stratigraphic section

Tertiary

Miocene(?)

Tv VOLCANICLASTIC SEDIMENTS — *Light-gray to dark-gray; consists of beds of stream-laid air-fall tuff and sedimentary detritus. Massive; locally thick bedded. Forms gentle slopes and low hills. May be correlative with the Moroni Formation. Stable. Thickness uncertain; possibly about 500 ft (150 m).*

Eocene

Tu UINTA(?) FORMATION — *Pale-red and gray, locally reddish-brown and light-brown siltstone that contains beds of medium- to coarse-grained quartzose sandstone, and sparse interbedded conglomerate and limestone. Thin to medium bedded; even bedded. Moderately stable. About 300 ft (90 m) thick.*

Tgc GREEN RIVER AND COLTON FMS., UNDIVIDED:
GREEN RIVER FORMATION — *Greenish-gray to light-gray mudstone that contains a few interlayered, thin, light-gray limestone beds. Commonly massive. Locally unstable when wet. Forms gentle to moderate slopes, Thickness uncertain; possibly as much as 100 ft (30 m).*
COLTON FORMATION — *Commonly pale-red and light-gray, alternating mudstone beds; locally pale-red mudstone mottled by abundant fragments of light-gray mudstone. Some thin light-brown clayey limestone beds near base. Massive, but thin bedded in places. Unstable when wet. About 400 ft (120 m) thick.*

Paleocene

Tf FLAGSTAFF LIMESTONE — *Light-gray to gray and yellowish-gray limestone that contains interlayered beds and lenses of dark-gray shale. Thin to medium bedded; even bedded. Dense, finely crystalline, fossiliferous. Resistant. Stable. Ranges in thickness from about 100 to 600 ft (30 to 185 m).*

Upper Cretaceous

TKn NORTH HORN FORMATION — *Reddish-brown, light-brown, gray and greenish-gray mudstone that contains interlayered beds of light-brown to light-gray sandstone, conglomeratic sandstone, conglomerate, and a few thin limestone beds similar to those that form the Flagstaff Limestone. Medium bedded to massive. Mudstone is very unstable when wet, and tends to slump, consequently, outcrops of the North Horn are almost completely concealed beneath large and small slump masses mapped in this area as "Old landslide deposits" (Qld). Ranges in thickness from about 50 to 3500 ft (15 to 1065 m).*

Cretaceous

Kpr PRICE RIVER FORMATION — *Brown and gray conglomerate, conglomeratic sandstone, and sandstone. Thick bedded to massive; commonly crossbedded. Larger clasts are well rounded and composed chiefly of tan quartzite, gray quartz, and dark-blue limestone. Forms cliffs and steep slopes. Stable. Thickness uncertain; only about 200 ft (60 m) of the formation is exposed in mapped area.*

Ki INDIANOLA GROUP, UNDIVIDED — *Light-brown to light-gray quartzose sandstone, thin to medium bedded, even bedded; locally crossbedded. Friable, poorly cemented by calcium carbonate. Stable. Forms steep slopes. Thickness uncertain because entire unit is not exposed. Possibly as much as 3,000 ft (914 m) thick in mapped area.*

T(Ja) ARAPIEN SHALE — *Calcareous mudstone beds may have been moved repeatedly in the past as a result of recurrent movement of contained salt and other evaporites (Witkind, 1982). Latest such intrusive episode possibly occurred during the Tertiary; this emplaced age is shown by a T that is added to the symbol (Ja) that represents the depositional age of Middle Jurassic.*

Jurassic

Upper Jurassic

Jm MORRISON(?) FORMATION — *Variegated mudstone in shades of red, purple, and gray; thick bedded to massive. Locally unstable. Weathers to low slopes and rounded hills. Thickness uncertain because entire unit not exposed. About 1000 ft (300 m) poorly exposed in mapped area.*

Upper and Middle Jurassic

Jtg TWIST GULCH FORMATION — *(Only on cross section). Elsewhere in central Utah consists of reddish-brown beds of sandstone, shaly siltstone, and shale, and interlaminated light-gray thin sandstone. Thin to medium bedded. Even bedded. Stable. Thickness estimated to be about 1500 ft (460 m).*

Ja ARAPIEN SHALE — *(Only on cross section). Gray, calcareous mudstone locally mottled by pale-red blotches; some interbedded light-brown thin sandstone and calcareous shaly siltstone beds. Thin and even bedded. Units are lenticular and pinch in and out. Some sandstone beds are crossbedded. In places units are intensely contorted by internal flow. Elsewhere in central Utah contains large amounts of salt and other evaporites. Easily eroded to form intricately dissected gentle slopes. Very unstable when wet. Thickness unknown; estimates range from 3000 to 13,000 ft (915 to 3960 m).*

Jtc TWIN CREEK LIMESTONE — *Gray to light-gray, locally greenish-gray limestone that contains minor units of mudstone, calcareous shaly siltstone, and fine-grained sandstone. Distinctive reddish-brown sandstone and shaly siltstone at base. Thin to medium bedded; even bedded. Limestone units disintegrate into thin angular platy fragments. Limestone is dense, and extremely fine grained. Forms steep slopes. Stable. Ranges in thickness from 600 to 800 ft (180 to 250 m).*

Lower Jurassic and Upper Triassic(?)

JꞀn NUGGET SANDSTONE (also known as NAVAJO SANDSTONE) — *Light-tan and reddish-brown quartzose sandstone; thick bedded to massive; crossbedded in large sweeping tangential festoons; fine to coarse grained. Moderately well cemented by calcium carbonate and iron oxide. Friable. Forms cliffs and steep slopes. In places, light-tan aspect is broken by large, irregular, reddish-brown mottles. These reddish parts consist of fine sand grains that are not as well cemented as light-tan parts, and thus are less likely to stand as vertical walls. Very stable. Thickness ranges from 1400 to 1500 ft (425 to 460 m).*

Triassic

Upper and Lower Triassic

Ꞁa ANKAREH FORMATION — *Reddish-brown to deep reddish-brown shaly siltstone and sandstone; thin to thick bedded; even bedded. Some sandstone units are crossbedded. Sandstones are fine to medium grained. Ripple marked. Forms gentle to moderate slopes and long strike valleys. Stable. About 1400 ft (425 m) thick.*

Lower Triassic

Ꞁt THAYNES LIMESTONE — *Reddish-gray limestone with some interlayered beds of red and gray shale; thin to medium bedded; even bedded. Forms moderate slopes and rounded hills. Limestone beds are very stable; interlayered shale units are unstable. Thickness about 1250 ft (380 m).*

Ꞁw WOODSIDE FORMATION — *Reddish-brown to dark-red shaly siltstone and fine-grained sandstone; thin to medium bedded; even bedded. Weakly cemented by iron oxide and calcium carbonate. Moderately resistant; forms valleys and gentle slopes. Moderately stable. Thickness about 200 ft (60 m).*

Permian

Ppc PARK CITY FORMATION — *Light-brown to light-gray; limestone that contains nodules and seams of chert; thin to medium bedded; even bedded. Resistant. Forms rounded hills and moderate slopes. Stable. Thickness about 700 ft (215 m).*

Pdc DIAMOND CREEK SANDSTONE — *Light-brown to orange-brown quartzose sandstone; thin to medium bedded; even bedded. Fine to medium grained. Well cemented by calcium carbonate. Forms cliffs and steep slopes. Stable. About 900 ft (280 m) thick.*

Pk KIRKMAN LIMESTONE — *Light-gray to dark-gray dense limestone, that contains some intraformational breccia; thin to medium bedded; even bedded. Stable. About 300 ft (90 m) thick.*

Permian and Pennsylvanian

PIPo OQUIRRH FORMATION — *In mapped area is a light-brown to brown, locally orange-brown quartzose sandstone; thin to medium bedded, locally massive; even bedded. Fine to medium grained. Forms cliffs and steep slopes. Stable. About 1000 ft (305 m) represented in mapped area.*

Pennsylvanian

SYMBOLS

CONTACT. *Approximately located or inferred in some places.*

INTRUSIVE SEDIMENTARY CONTACT. *Approximately located or inferred in some places. Black oblongs rest on intrusive sedimentary unit.*

FAULT. *Dashed where approximately located, dotted where concealed.*

CONCEALED THRUST FAULT. *Sawteeth on upper plate.*

50 *Strike and dip of inclined beds.*

Strike and dip of vertical beds

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