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GEOLOGIC MAP OF THE THOREAU QUADRANGLE, McKINLEY COUNTY, NEW MEXICO

BY

Jacques F. Robertson

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UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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Open-file report

1973

This report is preliminary and has not been edited or reviewed for conformity with U.S. Geological Survey standards and nomenclature.

GEOLOGIC QUADRANGLE MAP

THOREAU QUADRANGLE, McKINLEY COUNTY, NEW MEXICO

DESCRIPTION OF MAP UNITS

Qd DUNE SAND (HOLOCENE)--wind-blown sand and silt

Qal YOUNGER ALLUVIAL DEPOSITS (HOLOCENE)--mostly alluvial fan deposits and valley bottom sediments at level of modern drainage. 0-20 (0-6 m) thick

Qc COLLUVIUM (HOLOCENE AND/OR PLEISTOCENE)--fan talus and slope wash deposits

Qt TALUS AND LANDSLIDE DEPOSITS (HOLOCENE AND/OR PLEISTOCENE)

Qb RESIDUAL BOULDER DEPOSITS (HOLOCENE AND/OR PLEISTOCENE)--mainly diabase from Mount Powell intrusive

Qoa OLDER ALLUVIAL DEPOSITS (PLEISTOCENE?)--mostly dissected piedmont alluvial plain and fan deposits above the level of modern drainage. 0-60 feet (0-18 m) thick

Td DIABASE INTRUSIVE (TERTIARY)--Mapped only on Mount Powell

MANCOS SHALE (UPPER CRETACEOUS):

Km Main body--dark greenish- to olive-gray, friable, silty shale; minor interbedded, laminated, dark yellowish-brown sandy siltstone. Weathers very light gray. Top removed by erosion. Includes *Sciponoceras gracilli*-bearing limestone bed, 6 inches thick (15 cm) 23 feet (7 m) above base, that is correlated with Greenhorn Limestone. Well-exposed on south slope of Mount Powell

Kmw Whitewater Arroyo Tongue--medium to dark gray-green, fossiliferous, silty shale, weathers light yellowish-brown. Includes thin lenses, up to 8 feet (2.4 m) thick, of light yellowish-orange limestone having cone-in-cone structure, and yellowish-orange, calcareous, fine-grained sandstone and siltstone. 30-75 feet (9-21 m) thick

Lower part

Kmb Unit B[1/]--Yellowish-gray to grayish-brown, thin-bedded, fossiliferous siltstone, shale, fine-grained sandstone, and medium-gray to dusky-brown, fossiliferous limestone; scattered pods, as much as 4 feet (1.2 m) thick and tens of feet long, contain abundant detrital chert, quartz, and invertebrate fossil remains. Extensive *Exogyra*-rich oyster beds with calcareous siltstone matrix, as much as 5 feet (1.5 m) thick, in upper part. Top is generally a fine-grained, siliceous sandstone, 1 to 2 feet (0.3-0.6 m) thick, full of worm tubes, limestone pods, and pebble conglomerate lenses. Thins westward in outcrop; in western part intertongues with Dakota Sandstone and pinches out downdip to northwest. 0-13 feet (0-4 m) thick

Kma Unit A[1/]--In eastern part of area, pale orangish- to grayish-yellow, sparsely fossiliferous siltstone, shale, and thinly-bedded, platy calcareous sandstone. At top, two or more beds of fine-grained, well-sorted sandstone, each 4 to 8 feet (1.2-2.4 m) thick, interbedded with shale; contain scattered dark-brown, fossiliferous limestone lenses. Sandstone beds, in part churned by burrowing organisms (bioturbated), suggesting intertidal or nearshore deposition; grade into tabular crossbedded sandstone beds of beach or bar origin. Westward, unit becomes increasingly sandy and grades into Dakota Sandstone. 0-50 feet (0-15 m) thick

DAKOTA SANDSTONE (UPPER AND LOWER(?) CRETACEOUS):

Kdt Twowells Sandstone Tongue--grayish- to dark yellowish-orange, fine- to medium-grained, well-sorted, siliceous sandstone; in 1 to 3 beds, each 1 to 5 feet (0.3-1.5 m) thick, parallel-bedded, and separated by medium light-gray siltstone. Commonly contains worm borings. 3-12 feet (1-3.6 m) thick

Kd Main body--Pale grayish-yellow to brown, also pink and white, fine- to medium-grained, well-sorted, generally siliceous sandstone in cliff-forming beds that are as much as 80 feet (24 m) thick; includes minor interbedded light-gray to black carbonaceous shale, siltstone, and lignite that range from partings to beds 13 feet (4 m) thick, also thin beds of coarse-grained channel sandstone. Chert pebble conglomerate, 0.5 to 3 feet (0.15-0.9 m) thick, generally marks top in eastern part of area. Sandstone beds are variously massive, thin bedded, planar and trough crossbedded, burrow mottled, ripple marked, and contain plant remains; a few are slightly calcareous. Lagoonal, deltaic, and beach origins indicated. 90-168 feet (27-51 m) thick

MORRISON FORMATION (UPPER JURASSIC):

Jmb Brushy Basin Member--greenish- and reddish-gray, thinly bedded and laminated claystone, shale, and sandy, clayey siltstone. 80-110 feet (24-33.5 m) thick

Jmbs Sandstone lenses within the Brushy Basin Member--pale yellowish-gray, pink, and white, fine- to coarse-grained, poorly sorted, feldspathic sandstone; similar to Westwater Canyon Member. In lenses and channel units. 0-50 feet (0-15 m) thick

Jmw Westwater Canyon Member--moderate reddish-orange to reddish-brown, fine- to coarse-grained, poorly sorted, fluvially crossbedded, feldspathic sandstone, forms imposing cliffs; contains a few thin lenses of maroon claystone, locally very coarse sandstone and pebble conglomerate. Mottling from white kaolin, altered from feldspar, common. Intertongues with Recapture Member. 120-220 feet (36-67 m) thick

Jmr Recapture Member--dusky reddish- and greenish-gray and pale-gray, thin-bedded, shaly siltstone and claystone (more abundant in lower half); cream-colored to very light-gray and greenish-gray, very fine- to coarse-grained, poorly sorted, clayey, silty sandstone, locally calcareous and gypsiferous; and moderate grayish-pink to white and pale brown, fine- to coarse-grained, locally conglomeratic, poorly sorted, friable, fluvially crossbedded and channeled, feldspathic sandstone (more common in upper part, shown as Jmw where more than 15 feet (5 m) thick). Beds are lenticular and discontinuous. Intertongues with Cow Springs Sandstone. 130-230 feet (40-70 m) thick

COW SPRINGS SANDSTONE (UPPER JURASSIC):

Jcse Eolian facies--pale greenish-yellow and greenish-gray to light gray, in places grayish-pink, very fine- to fine-grained, well-sorted sandstone, with sweeping, high-angle, eolian crossbedding, in sets 10 to 30 feet (3-9 m) thick. Contains few thin interbeds and partings of flat-bedded, calcareous and gypsiferous sandstone and claystone. Contact with underlying fluvial facies sharp. 65-135 (20-40 m) feet thick

Jcsf Fluvial facies[2/]--mainly medium light greenish-gray to very light gray to white, but moderate reddish-gray to pinkish-gray to white and mottled in the lower third, fine-grained, well sorted, friable, in places calcareous sandstone; cliff-forming, predominantly fuvially crossbedded, but also eolian (more common in upper part), and interbedded silty, generally clayey, flat-bedded, thinly laminated to massive sandstone. Beds are 1 to 9 feet (0.3-2.7 m) thick (average about 3 feet (0.9 m)), commonly separated by reddish- or greenish-gray claystone partings generally much less than 1.5 feet (0.45 m) thick. Top is a persistent, medium greenish-gray, fine-grained, flatbedded, laminated and ripple-marked, silty, clayey sandstone bed, 8 to 10 feet (2.4-7 m) thick. Lower 40 feet (13 m) generally more silty and similar to Summerville Formation, with which it is interbedded, but is distinguished by 3 or 4 persistent marker beds of white, fine- to coarse-grained, well-sorted, fluvially crossbedded, highly calcareous sandstone, the lowermost 3-foot (1 m) bed of which defines the base of the Cow Springs Sandstone. 165-220 feet (50-67 m) thick

Js SUMMERVILLE FORMATION (UPPER JURASSIC)--Moderate red to grayish-pink and pale reddish-brown to very pale orange, rarely white, fine- to very fine grained, slightly to highly calcareous, silty sandstone, light greenish- and reddish-gray, sandy, clayey siltstone, and dusky grayish-red shaly claystone partings. Beds range from 0.5 to 4 feet (0.15-1.2 m) thick, generally flat-bedded, laminated to massive, rarely have small-scale crossbedding, some load casts and slump structures. Weathers to subdued slopes; poorly exposed. 100-125 feet (30-38 m) thick

Jt TODILTO LIMESTONE (UPPER JURASSIC)--light- to dark-gray, thin-bedded limestone. Upper 1 to 2 feet (0.3-0.6 m) generally recrystallized. Lower part includes interlaminated light-gray to reddish- and greenish-gray calcareous siltstone, fine-grained sandstone, and limestone, in layers 1/4-inch to 6 inches (0.6-15 cm) thick. Locally basal part consists of light pinkish- and yellowish-gray, flat-bedded to tangentially crossbedded, laminated, silty, calcareous sandstone as much as 15 feet (4.6 m) thick, reworked from the underlying Entrada Sandstone; generally marked in the basal foot or two by disturbed bedding, scouring, and flame and roll structures. 13-30 feet (4-9 m) thick

ENTRADA SANDSTONE (UPPER JURASSIC)[3/]:

Jeu Upper sandstone member--forms sheer, high cliffs; consists of reddish-orange to reddish-brown, medium- to fine-grained, well-sorted, eolian crossbedded sandstone, in cosets as much as 20 feet (6 m) thick. Upper half locally contains lenticular beds of flat-bedded, reddish-gray, fine-grained, calcareous, silty sandstone. In some places, the upper 1 to 10 feet (0.3-3 m) is bleached to very pale orange or brown. The lower 6 inches (15 cm) is bleached white. Locally, member not shown where exposed in vertical or overhanging cliffs. 150-200 feet (45-60 m) thick

Jem Medial siltstone member--dark reddish-gray, fine- to very fine-grained, argillaceous and calcareous sandstone and siltstone; subangular to subrounded grains. Well consolidated, seemingly massive with poorly defined bedding and laminations. Forms bold cliffs with columnar jointing and hoodoo-weathering features. Basal contact generally sharp, scoured, and load casted, having little or no relief. Locally not shown where exposed in vertical or overhanging cliffs. 40-50 feet (12-15 m) thick

Jel Lower sandstone member[4/]--moderate reddish-orange, fine- to medium-grained, well sorted and well rounded, eolian crossbedded sandstone; angular, white chert grains are concentrated along cross laminations. Contains randomly oriented calcite-filled joints. Weathers to moderate slopes and crumbling exposures. The upper 5 to 10 feet (1.5-3 m) is locally reworked, evenly laminated and flat bedded. Angular white chert and quartz grains up to pebble size occur in the basal 6 to 12 inches (15-30 cm). 45-60 feet (14-18 m) thick

CHINLE FORMATION (UPPER TRIASSIC):

₮co Owl Rock Member--white, and purplish- to greenish-gray mottled, cherty, nodular, clastic limestone, in two or three beds, each 1 to 4 feet (0.3-1.2 m) thick, interbedded with reddish- to purplish-gray claystone and siltstone. 25 to 40 feet (7.6-12 m) thick

Petrified Forest Member:

₮cpu Upper part--poorly exposed, dark to light purplish-gray and reddish-gray, clayey siltstone; includes medium to dark greenish- and purplish-gray, fine- to coarse-grained, poorly sorted, micaceous and lithic sandstone and conglomerate, in thin lenticular beds. Approximately 900 feet (270 m) thick

Ꝛcpc Correo Sandstone Bed--light greenish-gray and medium dark purplish-gray, thinly laminated, fine- to very fine-grained, fluvially crossbedded and channeled sandstone, containing many magnetite-rich partings; includes thin, poorly sorted, pebble conglomerate and medium- to coarse-grained sandstone containing red, green, gray, and white, subangular chert and sandstone grains and pebbles, minor shale, and red clay galls. Thins from east to west and pinches out near middle of quadrangle. 0-35 feet (0-10 m) thick

Ꝛcps Sonsela Sandstone Bed--pale yellowish-brown to white, medium- to coarse-grained, fluvially crossbedded and channeled sandstone, in beds as much as 20 feet (6 m) thick. Locally conglomeratic, and contains micaceous minerals, chert, and clay-altered feldspar. Lenses of reddish- to purplish-gray claystone and siltstone interbedded locally. Base not exposed (bed separates upper and lower parts of Petrified Forest Member)

CONTACT--Dashed where approximately located

U ~130' D 75 FAULT, SHOWING DIP--dashed where approximately located; dotted where concealed; queried where position or existence in doubt. Apparent displacement displacement shown in feet where measured; ~ indicates approximate displacement. U, upthrown side; D, downthrown side

SYNCLINE--showing trace of axial plane and bearing and plunge of axis; dotted where concealed

7 STRIKE AND DIP OF INCLINED BEDS

12 BEARING AND PLUNGE OF CHANNEL SANDSTONE

8200 8300 STRUCTURE CONTOURS--drawn on base of Dakota Sandstone. Dashed where datum surface has been eroded. Contour interval 100 feet. Datum is mean sea level

PORTAL OF ADIT

Correlation diagram of the upper part of the San Rafael Group, Cow Springs Sandstone and Morrison Formation showing stratigraphic names previously assigned to the units in the area of this map

O'Sullivan and Beaumont, (1957), OM-190		Smith (1954), Geology of the Thoreau quadrangle, New Mexico[5/]		Cooley and others (1969), Professional Paper 521-A, plate 1 (sheet 8 of 9)		Green (1971), Continental Divide quadrangle (open file), and this report.	
Morrison Formation	Brushy Basin member	Morrison formation	Brushy basin member[6/]	Morrison Formation	Brushy Basin Member	Morrison Formation	Brushy Basin Member
	Westwater Canyon member		Prewitt member		Westwater Canyon Member		Westwater Canyon Member
	Recapture Member		Chavez member		Recapture Member		Recapture Member
Zuni sandstone		Thoreau formation		Cow Springs Sandstone		Cow Springs Sandstone	Eolian facies
							Fluvial facies
Summervile formation				Summerville Formation	Upper sandy member	Summerville Formation	

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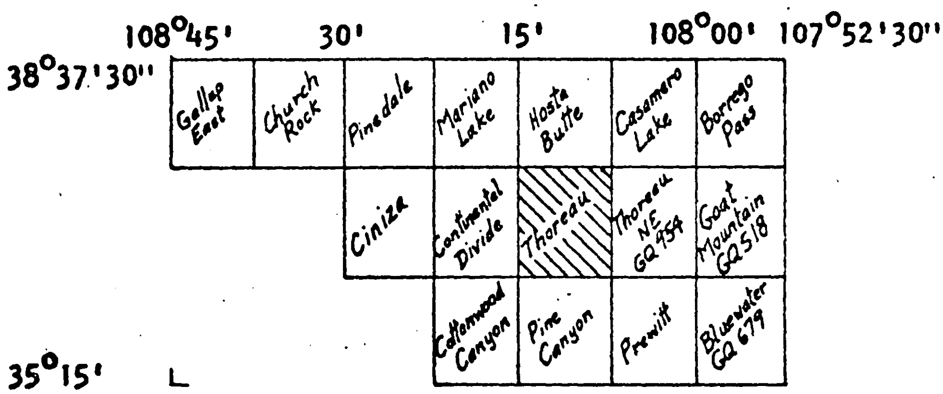


Index showing quadrangle locations and published geologic quadrangle maps.

[1]Units B (Kmb) and A (Kma) of the Mancos Shale are combined in the undifferentiated lower part of the Mancos Shale (Kml) in the Thoreau NE quadrangle (Green and Pierson, 1971), where splitting and lensing of intervening sandstone beds prevent their clear separation. They are readily distinguished in the Thoreau quadrangle, as in the Goat Mountain quadrangle (Thaden and others, 1966), however, because of the continuity of sandstone beds and a definitive fossil record.

[2]The fluvial facies (Green, 1971) shown on this map correlates with the Bluff Sandstone as mapped in the Ambrosia Lake-Goat Mountain area by Thaden and others (1966, 1967), and by Green and Pierson (1971); the eolian facies (Green, 1971) correlates with the unit mapped as Cow Springs Sandstone.

Harshbarger and others (1957, p. 43) state that the Bluff Sandstone as a mappable unit is confined to northeastern Arizona, the northwest corner of New Mexico, and southeastern Utah, and is inseparable from the Cow Springs Sandstone in the southeastern part of the Navajo country.

West of the quadrangle the eolian and fluvial facies intertongue, and grade from one to the other both laterally and vertically.

3/ Correlation diagram of nomenclature assignments of the Wingate and Entrada Sandstones as used by authors working in the Laguna-Grants-Gallup region, northwest New Mexico.

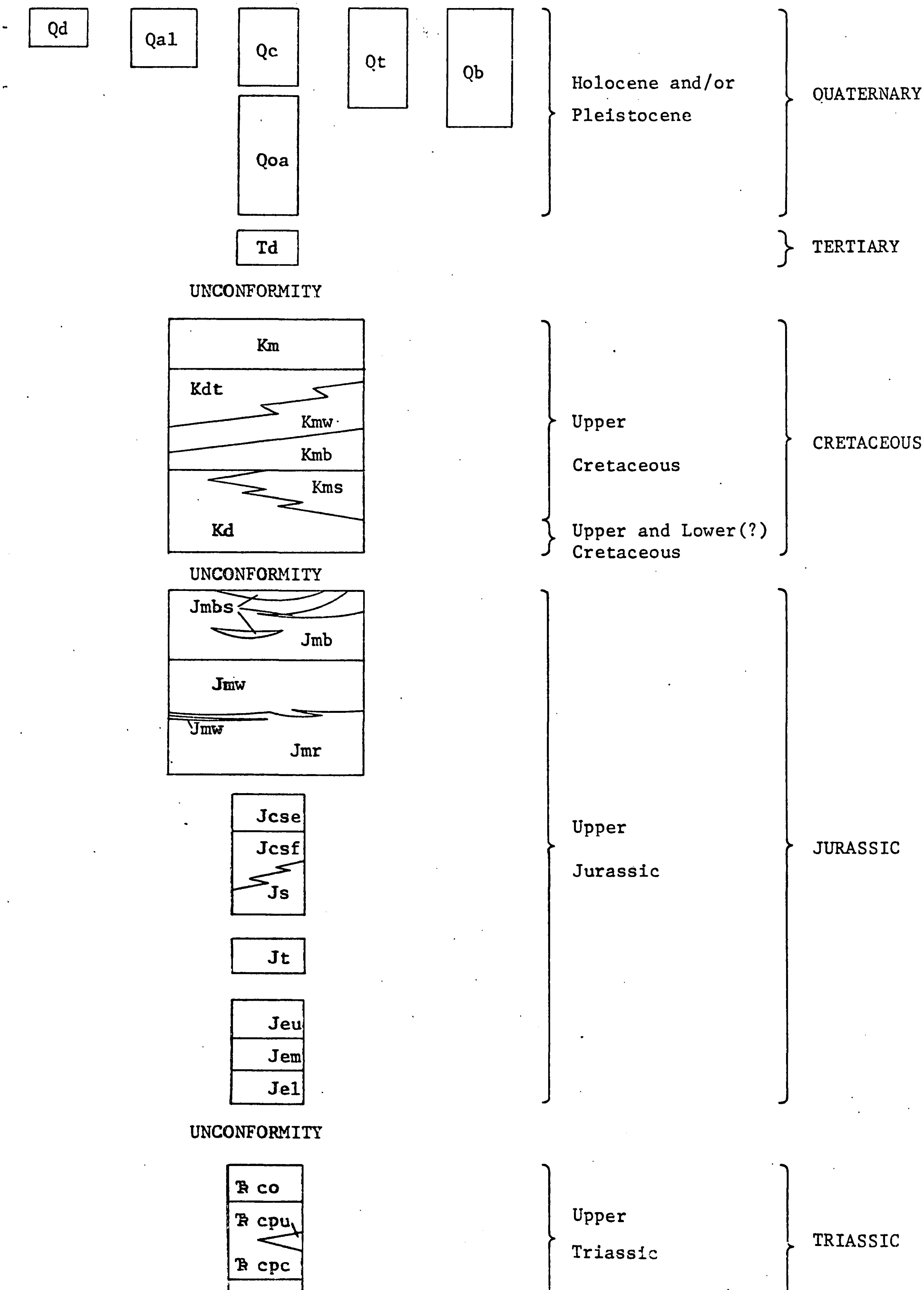
<table>
<tr><th>Dutton (1885)</th><th>Baker, Dane, and Reeside (1947)</th><th colspan="2">Silver (1948)</th><th>Rapaport, Hadfield, and Olson (1952)</th><th colspan="2">Smith (1954)</th><th colspan="2">Harshbarger, Repenning, and Irwin (1957)</th><th colspan="2">Moench and Schlee (1967)</th><th colspan="2">Green and Pierson (1971)</th><th colspan="2">Green (1971) and this map</th></tr>
<tr><td rowspan="4">Wingate sandstone (Triassic)</td><td>Entrada sandstone (Jurassic)</td><td rowspan="4">Wingate sandstone (Jurassic)</td><td>Upper cliff-forming member</td><td>Entrada sandstone (Jurassic)</td><td rowspan="2">Entrada sandstone (Jurassic)</td><td>Upper member</td><td rowspan="2">Entrada sandstone (Upper Jurassic)</td><td>Upper sandy member</td><td rowspan="4">Entrada Sandstone (Upper Jurassic)</td><td>Upper sandstone unit</td><td rowspan="2">Entrada Sandstone (Upper Jurassic)</td><td>Upper sandy member</td><td rowspan="4">Entrada Sandstone (Upper Jurassic)</td><td>Upper sandstone member</td></tr>
<tr><td>Carmel formation equivalent (Jurassic)</td><td>Middle slope-forming member</td><td rowspan="2">Carmel formation (Jurassic)</td><td>Lower member</td><td>Medial silty member</td><td>Middle siltstone unit</td><td>Medial silty member</td><td>Medial siltstone member</td></tr>
<tr><td rowspan="2">Glen Canyon Group Wingate sandstone(?) Navada sandstone(?) equivalent (Jurassic)</td><td rowspan="2">Lower cliff-forming member</td><td colspan="2" rowspan="2">Wingate(?) formation (Jurassic)</td><td rowspan="2">Wingate sandstone (Upper Triassic)</td><td rowspan="2">Lukachukai member</td><td rowspan="2">Lower sandstone unit</td><td colspan="2" rowspan="2">Wingate Sandstone (Upper Triassic)</td><td rowspan="2">Lower sandstone member</td></tr>
<tr><td>Wingate formation (Jurassic)</td></tr>
</table>

4/The lower sandstone member as shown on this map has previously been mapped in the Grants-Gallup region as the Wingate(?) Formation of Jurassic age by Smith (1954) and the Wingate Sandstone of Triassic age by O'Sullivan and Beaumont (1957), Smith and others (1959), Thaden and others (1967), Cooley and others (1969), and Green and Pierson (1971). In the adjacent Continental Divide quadrangle, Green (1971, open-file map) assigned it to the lower sandstone member of the Entrada Sandstone of Late Jurassic age, based on close lithologic similarities with the rest of the Entrada, absence of a regional unconformity between the lower sandstone and the overlying medial siltstone members, and, in fact, a gradational and interbedded relationship between them.

5/Thoreau 15-minute quadrangle of Smith includes later published 7 1/2-minute topographic quadrangles Thoreau NE, Thoreau, Prewitt, and Pine Canyon.

6/Brushy Basin Member changed to Casamero Member by C. T. Smith (1967, p. 135).

CORRELATION OF MAP UNITS



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True thicknesses and stratigraphic relations of beds at the outcrop are projected downdip to the plane of the section.

SCALE 1:12 000

0 — 1 MILE

0 — 1 KILOMETER

VERTICAL EXAGGERATION X2

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GEOLOGIC CROSS SECTION A-A', THOREAU QUADRANGLE, McKINLEY COUNTY, NEW MEXICO

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