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STRATIGRAPHY OF THE PALEOGENE CHUSKA SANDSTONE, NEW MEXICO-ARIZONA

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Abstract.—The Chuska Sandstone is a Paleogene, sandstone-dominated stratigraphic unit exposed along and around the crest of the Chuska Mountains in Arizona-New Mexico. The Chuska Sandstone consists of two members. The lower Deza Member is fluviatile in origin, as much as 81 m thick, and consists of ripple-laminated, trough-crossbedded and massive arkosic sandstone with significant interbeds of siltstone and claystone. The upper Narbona Pass Member, up to 535 m thick, is almost exclusively crossbedded arkosic sandstone of eolian origin. The only fossils known from the Chuska Sandstone are shell fragments of emydid turtles in the Deza Member that are indicative of perennial water, but, with an emydid stratigraphic range of Eocene-Recent, they are of little biostratigraphic significance. Radioisotopic data indicate that deposition of the Chuska Sandstone began ~35 Ma (late Eocene) and ended in the early Oligocene.

INTRODUCTION

Dutton (1885) first recognized the presence of a thick section of Cenozoic sandstones in the Chuska Mountains along the New Mexico-Arizona border (Fig. 1). He correlated them to early Eocene strata in the eastern San Juan Basin that Cope (1875) had described, and thus referred to the Cenozoic sandstones in the Chuska Mountains as the "Wasatch Sandstones." Gregory (1917) advocated the same correlation, but he named the strata in the Chuska Mountains the Chuska Sandstone. Two articles by Wright (1954, 1956) presented new and extensive data on the Chuska Sandstone, but no systematic studies have been published since then. Here, we review and revise the stratigraphy and age of the Chuska Sandstone (Fig. 2).

PREVIOUS STUDIES

Simpson (1850) noted sandstone and trap rock at "Washington Pass" (now Narbona Pass) in the Chuska Mountains. Following Dutton's (1885) observations, Darton (1910, p. 61, pl. 1) mapped the unit later named the Chuska Sandstone as "sands, sandstones, and conglomerates of early Tertiary age." Gregory (1916, p. 80, pl. 2) first used the name "Chuska sandstone" and mapped its distribution. Formal naming of the unit by Gregory (1917, p. 80) described the Chuska Sandstone as 213 m of sandstone above the "Tohachi shale" that forms "a resistant cover throughout the extent of the Chuska Mountains." Gregory described the unit as mostly crossbedded sandstone that is "medium to fine grained and consists of well rounded bits of clean white quartz with lesser amounts of red and of black quartz, volcanic ash, and rare muscovite." He also stated that northeast of Tohatchi, "the base of the Chuska sandstone is a bed of gray conglomerate with pebbles of quartz, sandstone, and shale one sixty-fourth to one-half inch [0.05 to 1.3 cm] in diameter." Gregory (1917, p. 81) also noted that no fossils were known from the Chuska Sandstone but that "its position and lithology suggest correlation with the Wasatch formation of north-central New Mexico."

Darton (1928, p. 56) described the Chuska Sandstone as 213 to 274 m thick and stated there was "no basis for precise correlation" of the unit. Hack (1942, p. 350), however, tentatively correlated

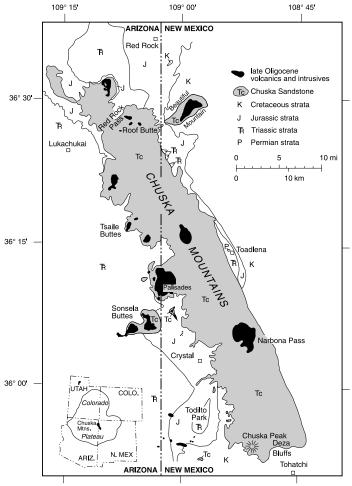


FIGURE 1. Generalized geologic map of the Chuska Mountains showing distribution of the Chuska Sandstone (after Wright, 1954).

the Chuska Sandstone with the Pliocene Bidahochi Formation of Arizona. Allen (1953) also advocated this correlation, and stated that the ~ 335 m thick Chuska Sandstone is separated by an angular unconformity from the underlying Cretaceous Tohatchi Formation.

Allen and Balk (1954) mapped the distribution of the Chuska Sandstone on the Tohatchi quadrangle, describing it as ~ 335 m

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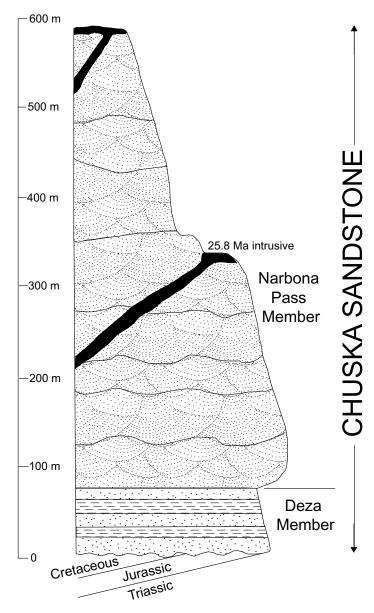


FIGURE 2. Generalized stratigraphy of the Chuska Sandstone (modified from Trevena, 1979).

of massive, crossbedded, silica-cemented sandstone that overlies, with angular unconformity, units that range from the Jurassic Summerville Formation to the Cretaceous Tohatchi Formation. They also correlated the Chuska with the Pliocene Bidahochi Formation, stating that strata similar to the Chuska crop out between Gallup and Zuni in New Mexico and near White Cone in Navajo County, Arizona. Repenning and Irwin (1954) were more explicit in their correlation, equating the Chuska Sandstone to the lower member of the Bidahochi Formation because of lithologic similarity, association with presumed contemporaneous volcanics and deposition on geomorphic surfaces of the same age.

In naming the Deza Formation, Wright (1954) separated the lower ~ 74 m of the Chuska Sandstone from the formation, recognizing it as a distinct lithostratigraphic unit characterized by "water laid" sandstone, claystone, siltstone and conglomerate

(Fig. 3). He stated that the Deza Formation has a gradational contact with the overlying Chuska Sandstone.

Wright (1956) undertook the most extensive published study of the Chuska Sandstone. He documented a maximum thickness of 533 m, and stated that it is unfossiliferous, crossbedded throughout, lacks shale and conglomerate and contains several thin ash beds. Wright considered the Chuska Sandstone to be of Miocene (?) age based on physiographic considerations.

In contrast, Repenning et al. (1958) still advocated a Pliocene(?) correlation. They also stated that the contact of Wright's Deza Formation with the overlying Chuska Sandstone "is gradational, [and] is very difficult to map" (Repenning et al., 1958, p. 128). For that reason, they did not recognize the Deza Formation as a separate lithostratigraphic unit (Fig. 3). Blagbrough (1967) summarized earlier work on the Chuska Sandstone and endorsed the lithostratigraphic conclusions of Repenning et al. (1958).

In a pioneering study of feldspar provenance, Trevena (1979) and Trevena and Nash (1978, 1981) documented the presence of significant volcanic feldspar in the Chuska Sandstone. Cather et al. (this guidebook) describe the genetic stratigraphy and provenance of the Chuska Sandstone, and present the first direct radioisotopic dates from the unit.

LITHOSTRATIGRAPHY

Gregory (1917) named the Chuska Sandstone for Chuska Peak, but no explicit description of a type section has been published. Here, we divide the Chuska Sandstone into two members (Figs. 2-3). The lower, Deza Member is the unit that Wright (1954) originally designated the Deza Formation. The upper, Narbona Pass Member, named here, is the Chuska Sandstone *sensu* Wright (1954, 1956) and is the bulk of the formation.

Deza Member

The Deza Formation of Wright (1954) is recognized by us as the Deza Member of the Chuska Sandstone. Wright (1954) coined the name Deza Formation for the lower 0–80 m of the Chuska Sandstone of Gregory (1917). He named it for the Deza Bluffs (Fig. 1) and described a type section there as 74 m thick,

Gregory (1917)	Wright (1954)	Repenning et al. (1958)	this paper	
Chuska Sandstone	Chuska Sandstone	Chuska Sandstone	ska Sandstone	Narbona Pass Member
	Deza] 권	Deza
	Formation		$^{\circ}$	Member

FIGURE 3. Changing lithostratigraphic nomenclature of the Chuska Sandstone and its subdivisions.

gradationally overlain by the Chuska Sandstone and resting with angular unconformity on the underlying Upper Cretaceous Tohatchi Formation. We remeasured this section (Figs. 4, 5A-C, Appendix) in greater detail than did Wright, but our observations confirm the accuracy of his published description.

Our measured type section of the Deza Member is ~ 81 m thick (Fig. 4). Two thirds (66%) of the measured section is sandstone; claystone (16% of the section) and sandy siltstone (16%) are significant components of the section. There is a single bed of volcanic tuff, and the basal bed of the Deza Member is a siliceous, extraformational conglomerate. Most of the sandstones are very fine to fine grained, arkosic and pale orange or yellowish-gray in color. Sandstone beds in the lower half of the type section are massive, ripple laminated or have thin, small-scale trough crossbed sets. However, the dominant sandstone bedforms in the upper half of the section are trough crossbeds of fluvial origin (Fig. 5C).

Deza Member sandy siltstone beds are mostly yellowish gray and calcareous, slope-forming units. The claystone beds are mottled or variegated pale orange, orange-pink and yellowish gray. They, too, are calcareous, slope-forming units. The interbedding of ledge-forming sandstones and slope-forming siltstones/claystones makes a good exposure of the Deza Member into a ribbed cliff (Fig. 5A-B), in contrast to the long slopes, thick

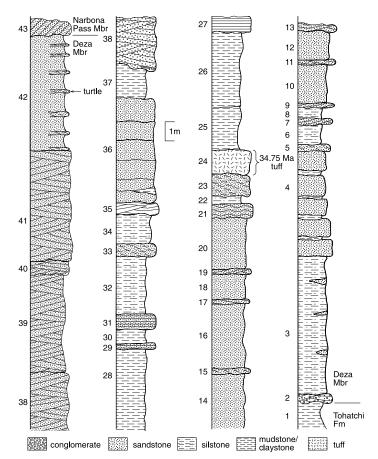


FIGURE 4. Type section of the Deza Member of the Chuska Sandstone. See Appendix for descriptions of numbered lithologic units.

bluffs and shoulders of hills formed by the overlying, sandstonedominated Narbona Pass Member.

A single bed of biotite-rich fallout tuff is present in the Deza Member type section (unit 24: Fig. 4; Fig. 5B). The basal bed of the Deza is a trough-crossbedded, silica-pebble conglomerate (unit 2: Fig. 4) directly above mudstone of the Upper Cretaceous Tohatchi Formation. The basal conglomerate is also well exposed to the southwest, near Chuska Peak, where it overlies the type section of the Tohatchi Formation (see Lucas et al., this guidebook).

As Wright (1954) observed, most sandstones of the Deza Member display bedforms (ripple laminations, small scale trough crossbeds) that indicate deposition by running water (Fig. 5C). Local occurrences of intraformational rip-up clasts in Deza Member sandstones confirm this conclusion. Nevertheless, some sandstone beds in the middle and upper part of the Deza Member type section contain horizontal laminations of well-sorted sand that closely resemble some eolian sandstones of the overlying Narbona Pass Member. This results in an interbedding in the upper part of the Deza Member of units of typical Deza Member lithotypes and typical Narbona Pass Member lithotypes. This interbedding supports Wright's (1954, 1956) assertion that the Deza-Narbona Pass contact is conformable.

The Deza Member appears to have its maximum exposed thickness at the type section. Elsewhere, it is thinner, and, at many outcrops of the basal Chuska Sandstone the Deza Member is absent, and the Narbona Pass Member rests directly on Mesozoic strata. Throughout the Chuska Mountains area, the Chuska Sandstone rests on a low-relief erosion surface that bevels Laramide folds (Tsaile surface of Schmidt, 1991). This erosion surface ranges in elevation from 7800 ft to about 8100 ft (2380 m to 2470 m). Note that our range of elevations for the basal contact of the Chuska Sandstone, which is based on mapping on a 1:24,000 topographic base and by GPS, differs somewhat from the range of Wright (1956; 7650–7900 ft, 2330–2410 m), which was determined by corrected altimeter readings. The Deza Member, as best as can be ascertained from poor exposure, is thickest in areas where the basal contact is lowest, suggesting that the Deza Member fills broad, shallow paleovalleys in the pre-Chuska erosion surface. Wright (1954) listed the most accessible outcrops of the Deza Member, and besides the type section, they include the flanks of Chuska Peak, the south-central flank of Beautiful Mountain, the northern end of Todilto Park, the escarpments north and east of Crystal and the southern flank of East Sonsela Butte.

The Deza Member is the "waterlaid" part of the Chuska Sandstone and contrasts with the eolian Narbona Pass Member. The lithologic distinction is in the ripple-laminated, massive and small-scale trough-crossbedded sandstone, conglomerate, claystone and siltstone of the Deza Member. These lithotypes are rare in the Narbona Pass Member, which is a nearly uniform succession of trough-crossbedded sandstone. Repenning et al. (1958) justifiably questioned the mappability of a Deza-Chuska (Narbona Pass) contact, thereby undermining the formation rank of Wright's (1954) Deza Formation. Nevertheless, the Deza is lithologically distinct from the rest of the Chuska Sandstone and deserves status as a separate member.

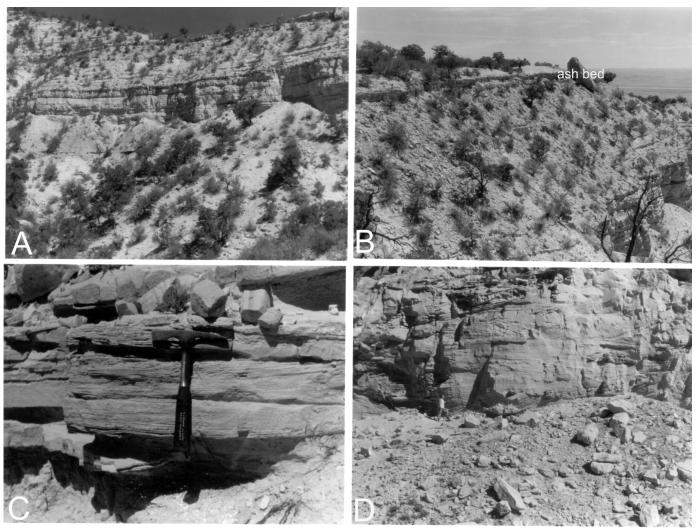


FIGURE 5. Photographs of selected outcrops of the Chuska Sandstone. A, Overview of type section of Deza Member. B, View on strike of part of Deza Member type section, showing prominent ash bed. C, Trough-crossbedded, water laid sandstone in Deza Member type section (unit 35 in Figure 3). D, Overview of type section of Narbona Pass Member.

Narbona Pass Member

We name the Narbona Pass Member of the Chuska Sandstone for Narbona Pass (formerly Washington Pass) in the southern Chuska Mountains east of Crystal, New Mexico (Fig. 1). The unit is as much as 360 m thick near Narbona Pass and consists entirely of pinkish-gray to yellowish-gray, crossbedded arkosic sandstone. However, because of soil and vegetation cover, a single, complete section of the Narbona Pass Member cannot be measured. Therefore, the type section of the Narbona Pass Member we designate is an incomplete section of the unit, but one that displays characteristic lithotypes of the member and well exposes its upper contact with pyroclastic debris of a Navajo volcanic field maar. We consider the boundary stratotype for the base of the Narbona Pass Member to be the type section of the Deza Member, where the contact between the two members is well exposed (Fig. 4). There, we define the upper contact of the Deza Member at the base of the lowermost, large-scale crossbedded sandstone of eolian character.

The type section of the Narbona Pass Member is an accessible outcrop of the upper part of the member. This is the south-facing roadcut of NM Highway 134 just west of Narbona Pass (Fig. 5D) at UTM zone 12, 691219E, 3995480N, NAD 27. Here, at least 20 m of trough-crossbedded, pinkish-gray, arkosic sandstone characteristic of the Narbona Pass Member are exposed and are overlain disconformably by pyroclastic debris of the Narbona Pass maar.

The Narbona Pass Member has a maximum thickness of about 535 m in the northern Chuska Mountains near Roof Butte and averages 275 to 335 m thick. It is almost exclusively pinkish gray and yellowish gray, very fine to medium grained arkosic sandstone (feldspar grains are 23–33% of total grains: Wright, 1956; Trevena, 1979). Stratification is dominantly large scale foreset crossbeds in 0.5-6.0 m thick sets. Cementation of the beds varies from opal and chalcedony cemented, well indurated ledges to friable slopes. The unit crops out along essentially the entire north-south length of the Chuska Mountains, and it represents the vast majority of the Chuska Sandstone in both thickness and outcrop area.

Where the Deza Member is present, the Narbona Pass Member has a conformable (gradational) lower contact with the Deza Member (see above). However, at many outcrops, the Narbona Pass Member rests with angular unconformity on the underlying Mesozoic strata. A variety of intrusives of the Navajo volcanic field cut the Narbona Pass Member (see below), and it is in most places overlain by alluvium, colluvium and soils of Pleistocene or Holocene age. Locally, however, the Narbona Pass Member is overlain by pyroclastic and extrusive volcanic rocks associated with intrusives of the late Oligocene-Miocene Navajo volcanic field. As noted by Gregory (1917, p. 99), the contact between the Narbona Pass Member and the overlying volcanic rocks is disconformable. Erosional paleorelief beneath lavas and tephras that locally overlie the Chuska Sandstone is at least several tens of meters, and may be much greater (e.g., Wright, 1956, p. 429; Appledorn and Wright, 1957, p. 454).

Wright (1956) and Trevena (1979) interpreted eolian deposition of the Narbona Pass Member by a complex of northerly migrating, transverse sand dunes. Repenning et al. (1958) argued instead for eolian paleotransport toward the east or northeast. Lovejoy (1976) suggested that the Chuska Sandstone was deposited by the ancestral Rio Grande or Colorado River, but no data support this idea.

FOSSILS

No fossils have previously been reported from the Chuska Sandstone. We discovered turtle shell fragments in the upper part of the type section of the Deza Member (unit 42: Fig. 4; Fig. 6). These fragments, as much as 3 cm x 3 cm in surface area, are concavo-convex, relatively thick (~1 cm), have smooth to slightly lineated external surfaces and some display shallow sulci. They clearly are carapace fragments of an emydid turtle (cf. Hay, 1908), but are not complete enough for a more precise identification. Emydids are almost exclusively aquatic turtles with a stratigraphic range of Eocene to Recent. The Deza Member emydid is thus of little biostratigraphic value, though it does suggest the presence of perennial water bodies during deposition of the Deza Member.

AGE

The first estimates of the age of the Chuska Sandstone assigned it to the early Eocene. Dutton (1885, p. 140), based on gross lithology and stratigraphic position, correlated it to the lower Eocene "Wasatch beds" (now San Jose Formation) in the east-central San Juan Basin. Dutton (1885, pl. 16) even used the term "Wasatch sandstones" for the unit later named the Chuska Sandstone. When Gregory (1917, p. 81) named the Chuska Sandstone he advocated the same correlation.

By the 1940s and 1950s, however, several workers assigned the Chuska Sandstone a Neogene age. Pliocene age assignments were based primarily on correlating the Chuska to the Bidahochi Formation of northeastern Arizona (e.g., Reiche, 1941; Hack, 1942; Allen and Balk, 1954; Repenning and Irwin, 1954). Supposed lithologic similarity and correlation of the erosion surface beneath the Chuska, Bidahochi and other Neogene units in the region formed the basis for this correlation.

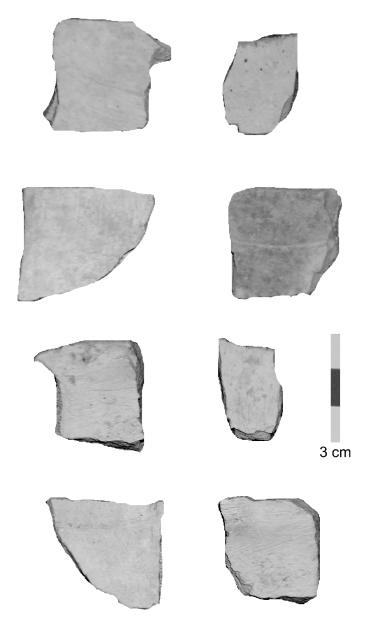


FIGURE 6. Fragments of emydid turtle shell observed in unit 42 of the Deza Member type section.

Wright (1956, p. 428-431) presented a detailed critique of previous correlations of the Chuska Sandstone and well explained their shortcomings. Instead, he advocated a Miocene? age for the Chuska Sandstone, based primarily on then accepted ideas about the geomorphological history of the Colorado Plateau (Gregory, 1947).

More recent data, however, indicate that Wright's age estimate was also incorrect. Several intrusives of the Navajo volcanic field cut the Chuska Sandstone (Fig.2), and thereby provide a way to estimate its minimum age. The oldest age of the intrusives in the field is about 28 Ma (Naeser, 1971; Trevena, 1979; Roden et al., 1979; Smith et al., 1985; Laughlin et al.,1986; Semken, 2001), thus indicating the Chuska Sandstone cannot be younger than early Oligocene or possibly early late Oligocene (the early-late Oligocene boundary is very close to 28 Ma: Berggren et al., 1995). Indeed, Laughlin et al. (1986) report a K/Ar age of 27.7

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 \pm 0.6 Ma for a dike they termed "Sonsela Butte" (a minette dike that extends southwest from West Sonsela Butte) that cuts the Chuska Sandstone. So, earlier assignments of a Neogene age to the Chuska Sandstone must be abandoned.

Cather et al. (this guidebook) present new 40 Ar/ 39 Ar ages for two ashes in the Chuska Sandstone. These dates, the first direct dates for the Chuska, are 34.75 ± 0.20 Ma (late Eocene) for the Deza Member and 33.31 ± 0.25 (early Oligocene) for the lower Narbona Pass Member. Maar-related trachybasalts that disconformably overlie the Chuska Sandstone near Narbona Pass have yielded a new 40 Ar/ 39 Ar weighted mean age of 25.05 ± 0.16 Ma (late Oligocene) (Cather et al., this guidebook). We can thus conclude that the Chuska Sandstone is of late Eocene-early Oligocene age.

ACKNOWLEDGMENTS

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APPENDIX—TYPE SECTION OF DEZA MEMBER

Measured at the Deza Bluffs, McKinley County, New Mexico. Base of section at UTM zone 12, 702071E, 3975486N, NAD 27, and top at UTM 701956E, 3975671N. Strata dip 5° to N20°W.

Chuska Sandstone:

Narbona Pass Member:

Sandstone; pinkish gray (5 YR 8/1); arkosic, a few feldspar grains; very fine to fine grained; not calcareous; trough crossbedded; friable.

not measured

Deza Member:

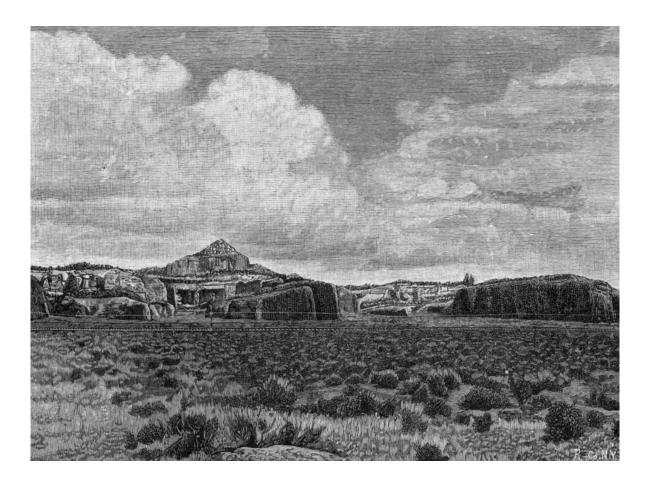
- Silty sandstone; yellowish gray (5 Y 8/1); subarkosic; very fine grained; calcareous; forms a slope broken by some thin, ripple-laminated sandstone; emydid turtle shell fragments at UTM 12, 702007E, 3975760N, NAD 27.
- 41. Sandstone; same colors and lithology as unit 38.
- 40. Sandstone; very pale orange (10 YR 8/2); fine to medium grained; slightly calcareous; trough crossbedded; a few rhizoliths; forms a ledge.

0.8

6.5

6.2

39.	Sandstone; very pale orange (10 YR 8/2); arkosic; very fine			external surface.	0.7
	grained; not calcareous; trough crossbedded; friable.	4.8	20.	Sandstone; same colors and lithology as unit 10.	2.7
38.	Sandstone; grayish orange (10 YR 7/4); arkosic; fine to		19.	Sandstone; yellowish gray (5 Y 8/1); arkosic; gypsiferous and	
	medium grained; some hematitic grains; not calcareous;			some biotite; very fine grained; trough crossbedded; ledge.	0.2
	trough crossbedded; some rip-ups of underlying claystone;		18.	Sandstone; same colors and lithology as unit 10.	1.2
	friable.	6.3	17.	Sandstone; yellowish gray (5 Y 8/1); subarkosic; very fine	
37.	Claystone; color mottled moderate orange pink (10 R 7/4) and			grained; calcareous; gyspiferous; trough crossbedded; ledge.	0.1
	very pale orange (10 YR 8/2); calcareous.	1.5	16.	Sandstone; same colors and lithology as unit 10.	3.3
36.	Sandstone; muddy; very pale orange (10 YR 8/2) and moderate		15.	Sandstone; same colors and lithology as unit 5.	0.2
	orange pink (10 R 7/4); arkosic and gypsiferous; fine to		14.	Sandstone; same colors and lithology as unit 10.	2.8
	medium grained; very calcareous; blocky with a thin (0.5 m)		13.	Sandstone; same colors and lithology as unit 5.	0.3
	red claystone band at its base.	5.5	12.	Sandstone; same colors and lithology as unit 10.	1.4
35.	Sandstone; very pale orange (10 YR 8/2); arkosic; very fine to		11.	Sandstone; same colors and lithology as unit 5.	0.2
	fine grained; not calcareous; trough crossbedded; forms a		10.	Sandstone; very pale orange (10 YR 8/2); subarkosic; very fine	
	ledge (Fig. 5C).	0.6		grained; not calcareous; friable; blocky and massive.	1.9
34.	Sandy siltstone; yellowish gray (5 Y 8/1); calcareous; slope.	1.5	9.	Sandstone; same colors and lithology as unit 5.	0.2
33.	Sandstone; pinkish gray (5 YR 8/1); arkosic; very fine grained;		8.	Sandy siltstone; same colors and lithology as unit 6.	0.4
	calcareous; gypsiferous; ripple laminated; indurated ledge.	0.8	7.	Sandstone; same colors and lithology as unit 5.	0.3
32.	Sandy siltstone; very pale orange (10 YR 8/2); slightly		6.	Sandy siltstone; yellowish gray (5 Y 8/1); calcareous; slope.	0.9
	calcareous; slope.	3.0	5.	Sandstone; yellowish gray (5 Y 8/1); subarkosic; very fine	
31.	Sandstone; very pale orange (10 YR 8/2); arkosic; very fine			grained; calcareous; ripple laminated ledge.	0.3
	grained; slightly calcareous; thinly laminated ledge.	0.8	4.	Silty sandstone and claystone; sandstone is yellowish gray	
30.	Silty claystone; same colors and lithology as unit 26.	0.7		(5 Y 8/1), claystone is light brown (5 YR 6/4); sandstone is	
29.	Sandstone; same colors and lithology as unit 27.	0.2		subarkosic, very fine grained and calcareous; thick (~ 0.5 n)	
28.	Silty claystone; same colors and lithology as unit 26.	4.4		tabular beds of sandstone intercalated with thin (2 cm)	
27.	Sandstone; very pale orange (10 YR 8/2); arkosic; very fine			claystone beds.	5.5
	grained; calcareous; gypsiferous; thinly laminated ledge.	0.8	3.	Sandy siltstone; light brown (5 YR 6/4); not calcareous; some	
26.	Silty claystone; yellowish gray (5 Y 8/1); calcareous; slope.	3.9		lenses of very fine grained subarkosic sandstone; forms a	
25.	Claystone; moderate orange pink (10 R 7/4); with a few thin			prominent "orange" band on outcrop; slope.	7.2
	(< 0.1 m) bands of tuff like unit 24; slope.	2.5	2.	Conglomerate; grayish orange (10 YR 7/4) and pale yellowish	
24.	Tuff; yellowish gray (5 Y 8/1) with black flecks of biotite;			brown (10 YR 6/2); clast supported; matrix is very coarse	
	fine grained; forms a prominent bluish colored ledge (Fig. 5B).	1.1		grained quartz sandstone; clasts are rounded chert, quartzite	
	40 Ar/ 39 Ar age 34.75 ± 0.20 Ma (Cather et al., this guidebook)			and petrified wood clasts up to 10 cm in diameter; trough	
23.	Sandstone; very pale orange (10 YR 8/2); arkosic; very fine			crossbedded; ledge.	0.3
	grained; calcareous; ripple laminated; ledge.	1.1	angular	angular unconformity	
22.	Sandy siltstone; yellowish gray (5 Y 8/1); not calcareous;			i Formation:	
	forms a prominent notch.	0.3	1.	Mudstone; yellowish gray (5 Y 7/2); bentonitic; not calcareous.	
21.	Sandstone; very pale orange (10 YR 8/2); gyspiferous			slope. not measu	
•	(gypsite); very fine grained; hummocky bedded with nodular			1	
	(CV1 // V 18 iii) iii ii j ii iii ii ii ii ii ii ii ii ii				



Dutton's (1885, fig. 11) woodcut photograph, described as "Pyramid Butte, near Fort Wingate, with promontories of the Wingate sandstone in front. The butte is composed of the Zuni sandstone."