The Iyanbito Member (A New Stratigraphic Unit) of the Jurassic Entrada Sandstone, Gallup-Grants Area, New Mexico

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GEOLOGICAL SURVEY BULLETIN 1395-D

The Iyanbito Member (A New Stratigraphic Unit) of the Jurassic Entrada Sandstone, Gallup-Grants Area, New Mexico

By MORRIS W. GREEN

CONTRIBUTIONS TO STRATIGRAPHY

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Description of a new stratigraphic unit and redefinition of stratigraphy along the Wingate cliffs, McKinley and Valencia Counties, New Mexico

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THE IYANBITO MEMBER (A NEW STRATIGRAPHIC UNIT) OF THE JURASSIC ENTRADA SANDSTONE, GALLUP-GRANTS AREA, NEW MEXICO

By MORRIS W. GREEN

ABSTRACT

In the Gallup-Grants area of New Mexico, a sandstone and siltstone sequence lying unconformably above the Chinle Formation of Late Triassic age and conformably below the middle siltstone member of the Entrada Sandstone of Late Jurassic age is here named the Iyanbito Member of the Entrada Sandstone. Previously, the Iyanbito interval was thought to be separated unconformably from the overlying members of the Entrada Sandstone; thus, it had been correlated with the Lukachukai Member of the Wingate Sandstone of Late Triassic age. Assignment of the Iyanbito as a member of the Entrada is here made for three reasons:

1. The contact between the Iyanbito and the overlying middle siltstone member is conformable throughout the area and is gradational at most places, indicating that deposition was continuous.
2. The base of the Iyanbito Member is marked by a laterally persistent erosional unconformity. Absence of an unconformity at the top of the Iyanbito therefore indicates that the unconformity at the lower contact is the boundary between Triassic and Jurassic rocks in the Gallup-Grants area.
3. The lithology and the mode and environments of deposition of the Iyanbito Member are closely related to those of the overlying members of the Entrada and are in contrast to those of the underlying Chinle Formation.

INTRODUCTION

A continental red-beds unit ranging in thickness from 12 to 44.2 m (40 to 145 ft) and composed mainly of reddish-orange sandstone and reddish-brown sandy siltstone is well exposed at the base of the Wingate cliffs east of Gallup in McKinley County, N. Mex. The unit crops out eastward from Gallup to the vicinity of Grants in Valencia County (fig. 1). Throughout the area the unit lies unconformably above either the Owl Rock Member or the Petrified Forest Member of the Chinle Formation of Late Triassic age and conformably below the middle siltstone member of the Entrada Sandstone of Late Jurassic age. The unit is herein named the Iyanbito (I-yän ′ -bĭtō) Member and assigned

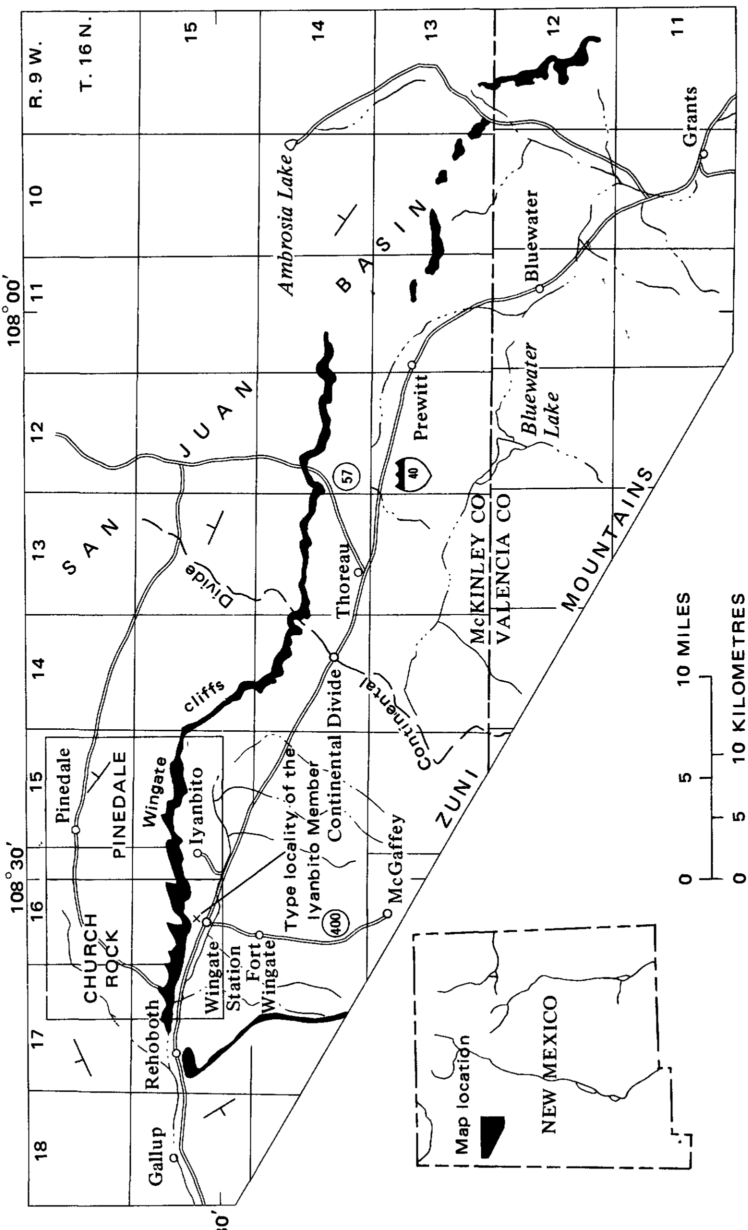

FIGURE 1.—Map of Gallup-Grants area, McKinley and Valencia Counties, N. Mex., showing outcrops of the Entrada Sandstone (solid). Base from U.S. Geological Survey 1:500,000 map of New Mexico.

to the Entrada Sandstone of Late Jurassic age. The Iyanbito is the lowermost of three members of the Entrada Sandstone recognized in the Gallup-Grants area (fig. 2).

Previously, the Iyanbito Member interval had been recognized as the Lukachukai Member of the Wingate Sandstone of Late Triassic age (Harshbarger and others, 1957, p. 8-12). The name Lukachukai Member of the Wingate Sandstone is here abandoned in the Gallup-Grants area.

This report is based on geologic mapping and related stratigraphic studies which began in 1967 in the southern part of the San Juan Basin. These studies have been carried out in conjunction with uranium resource investigations in the San Juan mineral belt by the U.S. Geological Survey.

The author is grateful to L. C. Craig, C. H. Maxwell, R. B. O'Sullivan, C. T. Pierson, G. N. Pipiringos, J. F. Robertson, and J. D. Strobell, Jr., of the U.S. Geological Survey for their help on local and regional stratigraphy during the course of several field conferences in the San Juan Basin and adjacent areas. The author particularly thanks C. T. Pierson and J. F. Robertson for their continued support and cooperation during field and office studies.

TYPE LOCALITY

The name Iyanbito means "Buffalo Springs" and is derived from the small Navajo Indian village located near the base of the Wingate cliffs in the Pinedale 7½-minute quadrangle approximately 19 km (about 12 mi) east of Gallup in McKinley County. The type locality is in the Church Rock 7½-minute quadrangle in the NW¼ sec. 15 (unsurveyed), T. 15 N., R. 16 W. The site of the type locality is in the northeast quarter of the Fort Wingate Military Reservation (old boundary, as shown in fig. 3). The locality is 4.42 km (2.75 mi) N. 76°30′ W. of Iyanbito and 2.54 km (1.58 mi) N. 37° E. of Wingate Station. Access thereto is by way of Wingate Station. (See road shown leading northeast from Wingate Station on the map, fig. 3.) In 1971, the railway station house which marked the site of Wingate Station near the Atchinson, Topeka, and Sante Fe Railway was demolished; the station house was approximately 105 m (about 350 ft) north of the intersection of New Mexico Highway 400 and Interstate 40 (fig. 3).

Stratigraphic section measured and described at the type locality of the Iyanbito Member of the Entrada Sandstone on July 21, 1971

	Meters	Equivalent feet
Entrada Sandstone (Jurassic):		
Middle siltstone member: Not measured; contact with Iyanbito Member conformable.		
Iyanbito Member:		
16. Sandstone, moderate-reddish-orange (10*R* 6/6); high-angle crossbedded; medium- to fine grained, well sorted, subrounded to well rounded, friable; mainly clear iron-stained quartz with minor dark accessory minerals; contains large amount of milky-white chert	5.79	19.0

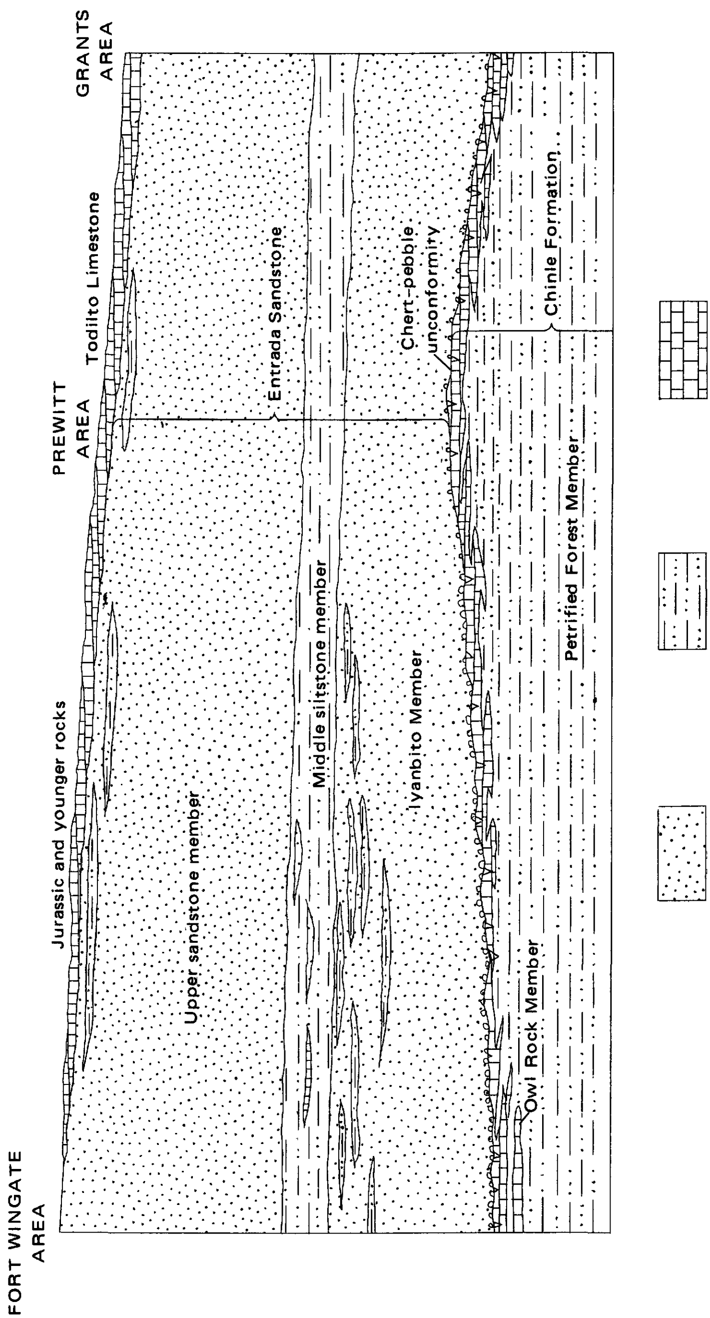

FIGURE 2.—Restored diagrammatic cross section showing general east-west relationships of the Entrada Sandstone and adjacent rocks in the Gallup-Grants area.

Stratigraphic section measured and described at the type locality of the Iyanbito Member of the Entrada Sandstone on July 21, 1971 — Con.

	Meters	Equivalent feet
Entrada Sandstone (Jurassic) — Con.		
Iyanbito Member — Con.		
15. Claystone and siltstone, dark-reddish-brown (10*R* 3/4); flat lens-shaped bed; laterally discontinuous	.03	.1
14. Sandstone, moderate-reddish-orange (10*R* 6/6), massive to crossbedded, fine to very fine grained, well-sorted; subrounded to well-rounded grains	2.13	7.0
13. Sandy siltstone, moderate-reddish-orange (10*R* 5/6), massive to flat bedded; calcareous locally; similar to middle siltstone member; polygonal mudcracks on upper bedding surface	5.18	17.0
12. Claystone and siltstone; same as unit 15	.1	.3
11. Sandstone, pale-yellowish-orange (10*YR* 8/6); upper few centimeters "bleached" greenish-gray (5*GY* 8/1); crossbedded, fine grained, well sorted; subrounded to well-rounded grains; friable; calcareous locally; some silty zones and stringer; white chert abundant	.61	2.0
10. Claystone and siltstone; same as unit 15	.1	.3
9. Sandstone; same as unit 11	1.22	4.0
8. Siltstone, reddish-brown (10*R* 6/4), massive; calcite cemented along lower surface	1.83	6.0
7. Sandstone, moderate-reddish-orange (10*R* 5/6), crossbedded, medium- to fine-grained, well-sorted; subrounded to well-rounded grains of white, pink, clear, yellow, brown, and black quartz. Crossbeds dip an average of 20° SW	3.05	10.0
6. Sandstone; same as unit 11	3.05	10.0
5. Sandy siltstone; same as unit 13	2.44	8.0
4. Sandstone; same as unit 7	2.13	7.0
3. Claystone and siltstone; same as unit 15	.03	.1
2. Sandstone; same as unit 7	10.21	33.5
1. Sandstone, yellowish-gray (5*Y* 8/1), grayish-red (5*R* 4/2), and moderate reddish-orange (10*R* 7/6), massive to crossbedded; coarse to fine grained, with pebbles and granules as much as 6 mm (about ¼ in.) across of white, black, clear, yellowish-green, gray, and pink quartz. Unit fills mudcracks as much as 1.2 m (4 ft) deep at the top of the underlying Owl Rock Member of the Chinle Formation	0.3	1.0
Total thickness of the Iyanbito Member	38.2	125.3
Chinle Formation (Triassic):		
Owl Rock Member: not measured; contact with overlying Iyanbito Member unconformable.		

LITHOLOGY, ORIGIN, AND THICKNESS

Throughout the area the Iyanbito is composed dominantly of reddish-orange (10*R* 5/6) crossbedded sandstone. In the western part of the area, where the Iyanbito is thickest, reddish-brown (10*R* 6/4) sandy siltstone is interbedded with the sandstone in the upper part of the member. Locally, a few very thin beds of dark-reddish-brown (10*R* 3/4) claystone are interbedded with the siltstone. The Iyanbito Member is friable and tends to weather to slopes and mounds at the base of the cliff carved in

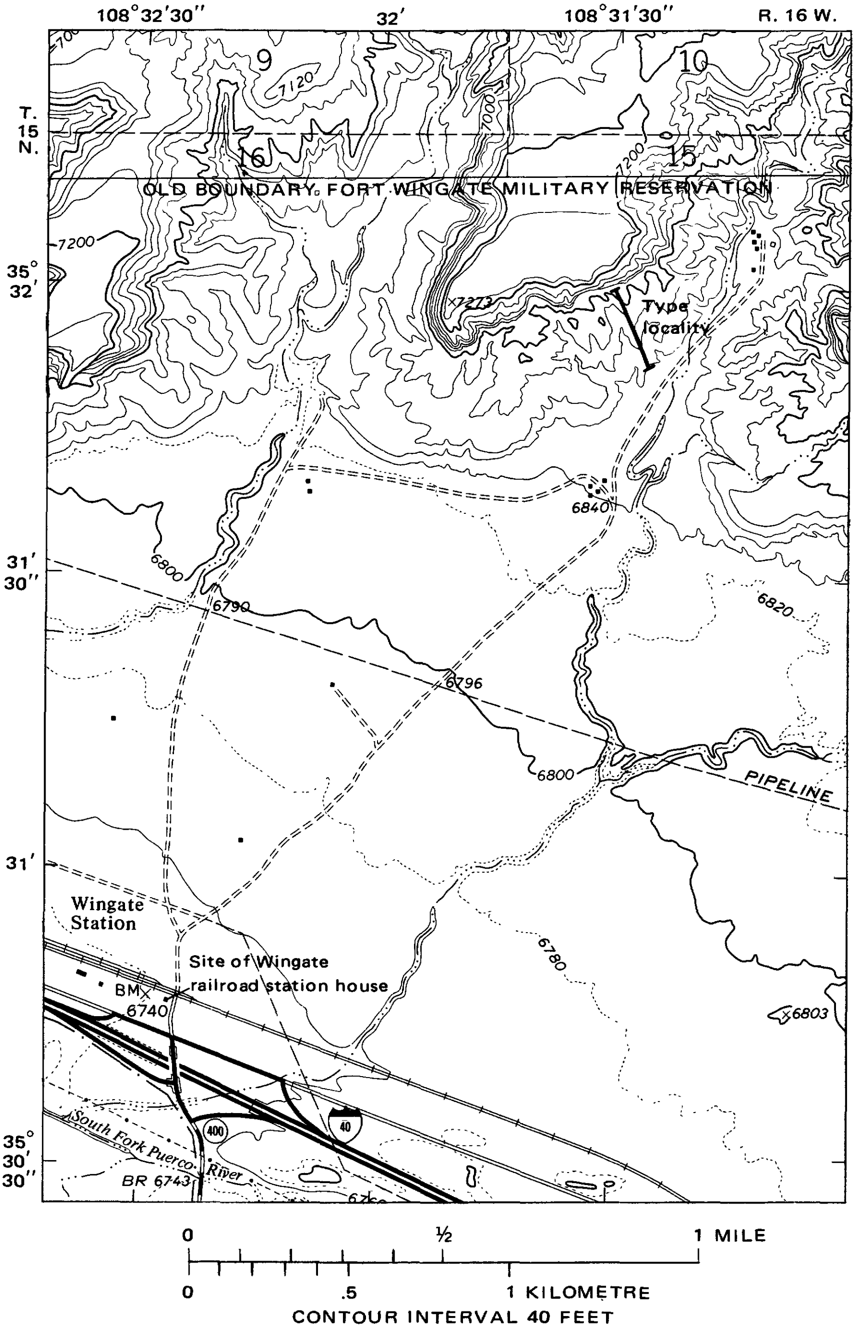

FIGURE 3.—Map showing location and access route for the type locality of the Iyanbito Member of the Entrada Sandstone. Base from U.S. Geological Survey Church Rock quadrangle, 1:24,000, 1963.

the overlying members of the Entrada Sandstone. The member lies on a dip slope formed by the more resistant limestone ledges in the underlying Owl Rock Member of the Chinle.

The Iyanbito Member is composed mainly of clear iron-stained quartz and minor amounts of feldspar and black accessory minerals. Milky-white chert grains are distinctive components. Grain size ranges from coarse to very fine, although most grains are medium to fine. The grains are well sorted, well rounded, and poorly cemented with calcium carbonate and iron oxide. Concentrations of white chert grains are distributed along crossbed laminations and in lenses scattered throughout the Iyanbito Member. These white chert grains also occur in the overlying members of the Entrada Sandstone. Pebbles and granules of white, red, and black quartz as large as 4 cm (1.6 in.) are concentrated in the basal part of the member. The pebbles and granules are conspicuous in the sand-filled mudcracks at the top of the underlying Chinle Formation. The pebbles, granules and distinctive white chert grains were derived from the underlying Chinle Formation and, for the most part, represent lag concentrations which were reworked into the basal part of the Entrada. The sandstone is characteristically cross-laminated at maximum high angles of 20° to 25°. The nature of crossbedding, sorting, and other lithologic and sedimentary features indicate an eolian origin for the sandstone. Crossbed orientations indicate a transport direction predominantly from the north-northeast toward the south-southwest throughout the area.

Several features characteristic of the sandstone in the Iyanbito are also found in the upper sandstone member of the Entrada. Lithology, mineralogy, origin, and transport directions are very similar. The upper sandstone member at places also contains interbedded siltstone of the same type and origin as that in the Iyanbito Member. There is, however, an overall decrease in grain size and amount of white chert grains in the upper member as compared with the Iyanbito.

From outcrops north of Continental Divide westward, the upper part of the Iyanbito Member contains several lenticular sandy siltstone beds which range in thickness from 0.3 to 5.5 m (1 to 18 ft). These siltstone beds are mineralogically similar to the adjacent sandstone beds; however, quartz is slightly more abundant, and the grains are more angular in the siltstone. Sand-size grains make up an estimated 10 to 15 percent of the siltstone beds. Individual beds are horizontally bedded to massive and locally contain oscillation ripple marks and mudcracks on their upper bedding surface. Polygonal mudcracks on upper bedding surfaces of the siltstone beds are commonly as much as 15 to 20 cm (about 6 to 8 in.) deep and 2.5 to 3.5 m (about 8 to 12 ft) across. Lithologically, the siltstone in the Iyanbito Member is indistinguishable from the siltstone of the overlying middle siltstone and upper sandstone members of the Entrada.

The origin of the siltstone beds in the Iyanbito Member and in the overlying members of the Entrada is probably similar to that of desert loess. Composition, grain size, and grain shape resemble those of modern loess deposits. The general lack of primary internal bedding features and the association of the siltstone beds with the eolian sandstone also suggest an eolian origin. Stream transport and deposition of most of these finer sediments seems unlikely because paleostream channels are only rarely found in association with the siltstone. It is more probable that the origin was a combination of loess and inland sebkha deposition. Silt winnowed from adjacent dune fields by the wind was probably deposited in shallow periodic interdune playas or inland sebkhas which were recharged periodically by a fluctuating water table at or near ground level in depressions between dunes and adjacent to dune fields in the deeper parts of the depositional basins. Ripple marks were probably formed during periods when the water table was high and the wind-deposited silts were submerged and subject to slight reworking by small wind-generated waves and ripples. Mudcracks, in turn, were probably formed during periods when the water table was low. Subsequently, the siltstone beds were buried by advancing dune sands.

The Iyanbito is thickest in the vicinity of Fort Wingate and Gallup, where both sandstone and siltstone lithologies are present. The average thickness in this area is 40 m (about 130 ft). The maximum thickness of 44.2 m (145 ft) was measured in the cliffs north of Wingate Station approximately 2 km (about 1.3 m) west of the type locality. The member is only about 12 m (about 40 ft) thick in outcrops north of Prewitt (fig. 1). East of Prewitt the base of the Iyanbito Member is covered in most places. Thaden and Ostling (1967) and Thaden, Santos, and Raup (1967) reported thicknesses of 100 to 120 feet (30.5 to 36.5 m) for the member (mapped by them as Wingate Sandstone) in the Bluewater and Grants quadrangles.

LOWER AND UPPER CONTACTS

The lower contact is sharp and unconformable throughout the Gallup-Grants area and is emphasized by a basal conglomerate, large-scale mudcracks, erosional relief, and a sharp contrast in lithology between the Chinle Formation and Iyanbito Member. The lag concentrations of chert and quartz pebbles in the basal conglomerate are a characteristic feature of the unconformity at the base of the Entrada Sandstone; for this reason, the lower contact has been informally referred to as the "chert-pebble unconformity" in the area of this report and elsewhere on the Colorado Plateau. Work by G. N. Pipiringos (oral commun., 1969) indicates that the chert-pebble unconformity is widespread throughout the Colorado Plateau and adjacent regions. The contact is also marked by large-scale mudcracks in the top of the Chinle

Formation. These structures are as much as 0.8 m (2.5 ft) wide and are filled to a depth as much as 3 m (about 10 ft) with sandstone and pebbles from the overlying Iyanbito Member. Multicolored claystone, siltstone, sandstone, and limestone deposited under humid conditions in freshwater fluviatile, lacustrine, and marsh environments of the Chinle below the contact contrast sharply with the sandstone and siltstone deposited by wind under extremely arid conditions in the desert environments of the Entrada above the contact.

Erosional relief at the lower contact generally is minor because of the resistant nature of the underlying limestone of the Owl Rock Member. At one place, northeast of Iyanbito approximately 2.5 km (about 1.5 mi), however, the Owl Rock is truncated by the unconformity at the base of the Iyanbito Member. Laterally from this locality the Iyanbito Member rests on the Petrified Forest Member of the Chinle for a distance of about 3.2 km (2 mi). No angular unconformity between the Chinle Formation and Entrada Sandstone was found.

The upper contact of the Iyanbito with the middle siltstone member is gradational and difficult to locate in the western part of the area because deposition was continuous from the Iyanbito Member to the middle siltstone member. The contact, for mapping purposes, is placed at the base of the lowermost thick siltstone bed which has lateral continuity. From the Continental Divide eastward, the contact is more distinctive in that the Iyanbito does not contain siltstone beds in its upper part. The contact is placed at the point of lithologic contrast between orange eolian crossbedded sandstone of the Iyanbito Member and loess-deposited reddish-brown siltstone of the middle siltstone member. The contact is also marked by laterally discontinuous beds of light-greenish-gray (*5GY* 8/1) calcareous sandstone 0.3 to 0.6 m (1 to 2 ft) thick at the top of the Iyanbito Member. These light-colored sandstone beds mark a local break in Entrada deposition prior to deposition of the overlying siltstone of the middle member in the eastern part of the area. No evidence of erosion was found in association with these bleached sandstone beds. Primary bedding structures (crossbeds) are preserved in these bleached units. These breaks in deposition are intraformational because they are laterally discontinuous and the same contact farther west is gradational. Similar light-colored sandstone beds can be found marking other local breaks in Entrada deposition at other stratigraphic levels in the formation. Because of the erratic distribution and nature of these minor breaks, they are not considered evidence of a major unconformity when found coincident with the otherwise conformable Iyanbito—middle siltstone member contact.

AGE AND PREVIOUS CORRELATIONS

Jurassic rocks between the Chinle Formation and Todilto Limestone in the Gallup-Grants area have been variously assigned in past studies

TABLE 1.—*Nomenclature for the stratigraphic interval between the Chinle Formation and Todilto Limestone in the Gallup-Grants area*

<table>
<tr><th>Dutton (1885)</th><th>Baker, Dane, and Reeside (1947)</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">This report</th></tr>
<tr><td colspan="9">Todilto Limestone</td></tr>
<tr><td rowspan="3">Wingate Sandstone (Triassic)</td><td>Entrada Sandstone (Jurassic)</td><td>Entrada Formation (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="3">Entrada Sandstone (Upper Jurassic)</td><td>Upper sandstone member</td></tr>
<tr><td>Carmel Formation equivalent (Jurassic)</td><td>Carmel Formation (Jurassic)</td><td>Lower member</td><td>Medial silty member</td><td>Middle siltstone member</td></tr>
<tr><td>Glen Canyon Group – Wingate(?) Navajo(?) equivalent (Jurassic)</td><td>Wingate Formation (Jurassic)</td><td colspan="2">Wingate(?) Formation (Jurassic)</td><td>Wingate Sandstone (Upper Triassic)</td><td>Lukachukai Member (Triassic)</td><td>Iyanbito Member</td></tr>
<tr><td colspan="8"></td><td>UNCONFORMITY</td></tr>
<tr><td colspan="9">Chinle Formation</td></tr>
</table>

(table 1). Jurassic rocks in the Gallup-Grants area are isolated from equivalent rocks elsewhere on the Colorado Plateau, and abruptly changing facies and lack of fossils have made previous correlations difficult and confusing. Because of this fact, correlation of the Iyanbito Member with equivalent rocks outside of the Gallup-Grants area is purposely avoided in this report. Additional study is necessary before sound regional correlations can be made with certainty.

The age of the Iyanbito Member is considered to be Late Jurassic in this report. The absence of fossils in the Iyanbito Member necessitates assignment of the unit to the Late Jurassic based on stratal and depositional relations with adjacent units. Similarity in origin and lithology, as well as the conformable relation with overlying members of the Entrada, indicates these units to be similar in age. Deposition was continuous from the Iyanbito to the middle siltstone member. Previous assignment of Iyanbito rocks to the Upper Triassic Wingate Sandstone (table 1) was based on the presence of an unconformity believed to occur between the Iyanbito and middle siltstone members. No evidence of such an unconformity is present.

Rocks of the Iyanbito Member were originally included in the Wingate Sandstone as named and described by Dutton in 1885 (p. 136-137). The name Wingate was derived from Fort Wingate, located about 16 km (about 10 mi) east of Gallup. Excellent exposures of the sequence lie in the orange cliffs, locally called the "Wingate cliffs," about 1.9 km (about 1.2 mi) north of Wingate Station. Subsequent workers have considered this to be the locality described by Dutton. Dutton's locality is about 2 km (about 1.3 mi) west of the type Iyanbito locality.

Baker, Dane, and Reeside (1947) correlated the Entrada Sandstone at the type locality in the San Rafael Swell of central Utah with the upper part of Dutton's Wingate Sandstone in the Fort Wingate area. At the same time they abandoned the type locality but retained the name Wingate for the lowermost formation of the Glen Canyon Group. The lower part of Dutton's Wingate (Iyanbito and middle siltstone members of the present report) was divided, respectively, into equivalents of the Glen Canyon Group and Carmel Formation (table 1). Baker, Dane, and Reeside were uncertain as to which formation of the Glen Canyon Group was present in the Fort Wingate below their Carmel equivalent, but they suspected that it was either the Wingate, as redefined, or an equivalent of the Navajo Sandstone.

During the period 1947-57, Rapaport, Hadfield, and Olson (1952), and Smith (1954) made other interpretations in correlation and nomenclature of the Entrada interval (table 1).

Harshbarger, Repenning, and Irwin (1957, p. 8, 35) confirmed the correlation with the Entrada made by Baker, Dane, and Reeside (1947) but were not in agreement with correlation of the Carmel Formation into the Fort Wingate area. Therefore, they recognized two informal members of the Entrada in the Fort Wingate area, namely the "medial silty member" and the overlying "upper sandy member." The Glen Canyon equivalents below the Entrada were correlated with the Lukachukai Member of the Wingate as defined in northeast Arizona (Harshbarger and others, 1957, p. 10).

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