STRATIGRAPHIC SECTION OF TOROWEAP AND KAIBAB FORMATIONS IN PARASHANT CANYON, ARIZONA

E. E. SCHLEH
DEPARTMENT OF GEOLOGY, TRINITY UNIVERSITY
SAN ANTONIO, TEXAS

INTRODUCTION

General

The Kaibab and Toroweap Formations (Middle Permian) of the Arizona Grand Canyon region are among the most famous stratigraphic units in the world. However, in spite of the fame of these units, most of the published stratigraphic data concerning them relates to only a few sections within the relatively small area of Grand Canyon National Park. Westward from these classical sections many important changes can be observed within the Toroweap-Kaibab interval.

It is the primary purpose of this paper to present a detailed section of the Toroweap and Kaibab Formations in the western part of the Grand Canyon region in the hope that it might help to clarify some of the regional stratigraphic relationships in this part of Arizona and adjacent areas.

Location

The strata studied in this investigation are located in northern Parashant Canyon, in the southern Shivwits Plateau, Mohave County, Arizona. Parashant Canyon joins the Grand Canyon about twelve miles south of this area, and about seventy miles west of the town of Grand Canyon.

Four complete stratigraphic sections of the Toroweap and Kaibab Formations were measured and described. The sections are located as follows: sec. 1, T. 33 N., R. 10 W.; sec. 35, T. 34 N., R. 10 W.; sec. 3, T. 33 N., R. 10 W.; and sec. 12, T. 33 N., R. 10 W. With certain minor exceptions, all four sections are virtually identical. In the detailed descriptions of each unit, these four sections are treated as a single composite section so that the minor local details peculiar to only one section are eliminated. It is believed that this method of presentation gives a much more accurate portrayal of the Toroweap and Kaibab Formations in Parashant Canyon than would any single measured section. All thicknesses given for the units are an average of the four sections.

STRATIGRAPHY

Nomenclature

Darton (1910) named the marine Permian succession of northern Arizona the Kaibab Limestone. Noble (1914) first subdivided the Kaibab into members, emphasizing the importance of lithologic types other than lime-

stone. In the western part of the Grand Canyon region, a five-fold lithologic division and topographic expression of the Kaibab Formation came to be recognized. McKee (1938) proposed that the lower three subdivisions be named the Toroweap Formation from typical exposures in Toroweap Valley, and that the name Kaibab be restricted to the two upper units. McKee named the three subdivisions of the Toroweap the Gamma, Beta, and Alpha Members, from bottom to top. In a like manner, he divided Kaibab into the Beta and Alpha Members.

Toroweap Gamma Member

The lowermost or Gamma Member of the Toroweap Formation overlies the Coconino Sandstone, forming a slope between the Coconino cliff and the steep cliff of the Toroweap Beta.

The position of the lower contact with the Coconino Sandstone is somewhat arbitrary within Parashant Canyon. In an effort to determine the position of the boundary, the writer used the following criteria: (1) The lowest horizon at which the fine- to medium-sized, Coconino-like quartz grains become dispersed in a silty matrix, (2) the lowest position at which carbonate rocks become abundant, and (3) the topographic break at the top of the Coconino ledge. Unfortunately, even using these criteria, the contact cannot be drawn with certainty anywhere. In some sections, prominent units of cross-bedded, Coconino-like sandstone are found high up in the Toroweap Gamma. In other sections, carbonates like those of the Gamma Toroweap are encountered below what is certainly the top of the Coconino. For these reasons, the writer interprets that, in this area, the Coconino and Toroweap Gamma were deposited under related conditions representing different parts of the same cycle of sedimentation, and are not separated by a significant unconformity.

Next in abundance to the gypstone, which makes up a little more than one-half of the succession, dolostone is quantitatively the most important lithologic type in the Toroweap Gamma. The unfossiliferous, fine-grained, even textured nature of the dolostone and its close association with bedded gypstone suggest that it is most probably primary dolomite deposited chemically in a hypersaline environment. Some of the dolostone, however, may represent secondary dolomitization of chemically precipitated limestone.

No fossils were collected from the Toroweap Gamma.

Toroweap Beta

The Toroweap Beta in the Parashant Canyon area is a resistant, massive, cherty, fossiliferous, marine limestone having an average thickness of about 205 feet. The unit is exposed in a steep cliff exhibiting little variation in topographic expression. The entire Toroweap Beta forms a single genetic unit showing only subtle vertical changes in lithology and fossil content.

However, within the area of study ten lithologic units seem to be significantly distinctive and laterally persistent to warrant separate treatment (see description of stratigraphic section).

The following fossils were collected from the Toroweap Beta: *Squamaria ivesi* (formerly Dictyoclostus ivesi), *Composita arizonica, C.* sp., *Pugnoides pinguis, Meekella* sp., *Derbyia* sp., small unidentified productid brachiopods, crinoid ossicles, spines of echinoids, fenestrate and ramose bryzoa, coiled and straight nautiloid cephalopods, small pectenoid pelecypods (rare, but most common near the top), and very small planicoiled gastropods (rare). All of these forms are encountered throughout the Toroweap Beta, but in varying relative abundance.

Toroweap Alpha

The massive limestone of the Toroweap Beta and the Kaibab Beta are separated by the slope-forming units comprising the Toroweap Alpha, which in this area has an average thickness of about 145 feet. The lithology of the Toroweap Alpha Member exhibits considerable vertical and horizontal variation. Rock types include bedded gypstone, dolostone, limestone, siltstone, claystone, sandstone, and intraformational breccia. The Toroweap Alpha of this region can be divided conveniently into only three very generalized lithological units (see description of stratigraphic section).

The only fossil found in the Toroweap Alpha was the single genus *Schizodus,* which is limited to a one-and-a-half foot thick bed of limestone near the top of the member. This bed of profuse *Schizodus,* which was reported at about the same stratigraphic position as far east as the Kaibab Trail (McKee, 1938), is one of the best marked beds in the entire Toroweap-Kaibab succession.

Kaibab Beta

The massive, cherty limestones of the Kaibab Beta of this region exhibit a general vertical similarity in lithology. Based on the lithology of the limestone alone, a valid division of the Kaibab Beta into smaller units is extremely difficult. However, vertical change in type and shape of the chert nodules was found to have great stratigraphic usefulness in the Parashant Canyon area (see description of stratigraphic section). The boundaries of the lithological units defined on the basis of chert are somewhat arbitrary in most sections. The total thickness of the Kaibab Beta in Parashant Canyon averages about 308 feet.

The fauna of the Kaibab Beta, although similar in many respect to that of the Toroweap Beta, is more varied and prolific. The following forms were collected from the Kaibab Beta: *Peniculauris bassi* (formerly Dictyoclostus bassi), *Marginifera* sp., *Chonetes kaibabensis, C.* sp., *Pugnoides pinguis,* small unidentified productids, fenestrate and ramose bryzoa, small rugose corals, crinoid ossicles, spines of echinoids, pectenoid pelecypods, small

planicoiled gastropods (rare), trilobites (rare), and sponges (in chert). Although all of these fossils are found throughout the Kaibab Beta, some fossils seem to be more common than others within certain intervals, and can be used to help define the lithological characteristics of those units.

Kaibab Alpha

The Alpha Member is composed of limestone ledges alternating with slope-forming units of siltstone, fine-grained sandstone, shale, and thin-bedded limestone. Throughout most of the Grand Canyon region, the relatively nonresistant Kaibab Alpha has been partially or completely removed by erosion. Fortunately, in this area the Kaibab Alpha is well represented in most sections. A complete section of Kaibab Alpha is about 120 feet thick in Parashant Canyon; however, differential, pre-Moenkopi erosion has rendered the thickness somewhat variable. How much strata was removed during the erosional interval between the cessation of Permian deposition and the deposition of the basal Moenkopi in the Early Triassic cannot be determined. Although many of the Kaibab Alpha units exhibit marked lateral variation, several persistent key beds are present, particularly units number 2, 4, 8, and 10 (see description of stratigraphic section).

In general, the fauna of the Kaibab Alpha is more molluscan than that of the Kaibab Beta. The following fossils were collected from the Kaibab Alpha: small pelecypods, bellerophontid gastropods, small high-spired gastropods, scaphopods, *Composita* sp., *Peniculauris bassi* (rare), fenestrate and ramose bryzoa, crinoid ossicles, echnoid spines, and worm burrows.

Stratigraphic section of Toroweap and Kaibab Formations, T. 33, 34N., R. 10 W., Parashant Canyon, Mohave County, Arizona. (Composite of four sections measured by E. E. Schleh and William L. Fisher.)

UNIT NO.	DESCRIPTION	FEET
	MOENKOPI FORMATION	
	Unconformity	
	KAIBAB FORMATION	
	Kaibab Alpha Member	
12.	Variable succession of gray, fine-grained limestone containing small concentrically banded chert nodules; siltstone; fine-grained sandstone; shale. Poorly exposed. Variable thickness.	25.0
11.	Covered slope; float and minor exposures of yellow, thin-bedded, sandy siltstone.	6.5
10.	Limestone, buff-gray, fine-grained to medium-crystalline, slightly arenaceous. An interlocking network of brown-weathering chert comprises 50% of unit. Unit expressed as conspicuous and persistent ledge.	5.5

UNIT NO.	DESCRIPTION	FEET
9.	Limestone, yellow-brown, very argillaceous, nodular; contains a few irregular chert nodules; fossil worm burrows common. Forms slope.	10.0
8.	Limestone, medium-gray, aphanitic to fine-grained hard, massive; subspherical nodules of chert as much as 0.5 foot in diameter common; contains abundant *Composita,* fenestrate bryzoa, crinoid ossicles, and echinoid spines. Forms ledge.	4.5
7.	Limestone, yellow, fine-grained, very argillaceous, thin-bedded; irregular nodules of blue-gray chert common; some interbedded siltstone. Forms slope.	4.6
6.	Limestone, gray, fine-grained, slightly impure; locally sandy, silty or dolomitic; varying amounts of chert; vugs lined with secondary calcite common; scattered fragments of fenestrate bryzoans and crinoid ossicles. Forms ledge.	12.0
5	Covered slope in most sections, but some thin-bedded, yellow siltstone, claystone, impure limestone, and intraformational breccia exposed.	10.0
4.	Limestone, light- to medium-gray, fine-grained, sucrosic textured, locally arenaceous; dolomitic in places; chert rare. Forms prominent ledge.	14.0
3.	Variable succession of contorted siltstone, silty limestone, intraformational breccia, fine-grained siltstone, claystone and gypstone.	8.0
2.	Limestone, light gray, fine-grained to fine crystalline; scattered elliptical, concentrically banded chert nodules that weather dark brown; poorly preserved bellerophontid gastropods common and characterize this unit. Forms sharp, angular ledge.	11.0
1.	Covered slope in most sections. Where exposed comprised either of very silty to sandy, thin-bedded limestone containing fractured chert nodules, of intraformational breccia. Most of the breccia is composed of small, angular, fragments of chert dispersed in a contorted matrix of calcareous siltstone; stained red or yellow in most sections.	7.0
	Total average thickness of Kaibab Alpha Member	118.0

Kaibab Beta Member

5.	Limestone, light-gray, fine-grained, hard, very cherty. Most chert as laminae of bedded chert or nodules greatly elongated parallel with bedding. Thickness ranges from 0 to 16 ft.	5.5

UNIT NO.	DESCRIPTION	FEET
4.	Limestone, like unit 3, but instead of white disseminated chert, most chert is as large subspherical nodules ranging from 6 to 9 inches in diameter ("cannonball chert"). Lower part of unit is a transition zone containing both the white disseminated and the "cannonball" chert. Thickness ranges from 95 to 155 feet.	120.0
3.	Limestone, light-gray, fine- to medium-crystalline, cherty, fossiliferous. White chert forming an interlocking, three-dimensional network characterizes this unit and in places comprises as much as 50% of the rock. Thickness ranges from 90 to 130 feet.	110.0
2.	Limestone, light gray, fine-grained to fine-crystalline, locally slightly sandy, fossiliferous; *Chonetes* especially common. Characterized by the presence of much less chert than any of the overlying units of the Kaibab Beta; chert that is present like that of unit 3. Thickness ranges from 50 to 80 feet.	65.0
1.	Breccia; consists mainly of angular, pebble-sized fragments of limestone, sandstone, siltstone and chert dispersed throughout a red- to orange-stained siltstone matrix.	4.0
	Total average thickness of Kaibab Beta Member	304.5
	Total average thickness of Kaibab Formation	422.6

TOROWEAP FORMATION

Toroweap Alpha Member

3.	Interbedded limestone, dolostone, siltstone, claystone, and intraformational breccia. Thin, angular beds of gray, fine-grained limestone and dolostone, much like that of unit 1, make up about one-half of unit. Except for one persistent 1.5 foot bed of gray, fine-grained, hard limestone containing vast numbers of the pelecypod *Schizodus*, the succession is extremely variable laterally.	20.0
2.	Gypstone, predominantly white, pure to impure; some beds contain carbonaceous matter concentrated along fractures and bedding planes. Thin beds and lenses of dolostone, siltstone, claystone and breccia scattered throughout succession. Thickness ranges from 87 to 126 ft.	112.0
1.	Limestone and dolostone, light- to medium-gray, aphanitic to fine-grained, hard, thin bedded, blocky. Some limestone is argillaceous to arenaceous. Most beds contain scattered, small, spherical nodules of concentrically banded chert. A few partings of siltstone are present in some sections.	16.7
	Total average thickness of Toroweap Alpha Member	148.7

UNIT NO.	DESCRIPTION	FEET
	Toroweap Beta Member	
10.	Limestone, light-gray, fine-grained, argillaceous, porous; scattered tan to gray, elliptical to irregular chert nodules. Vugs common; most filled with secondary calcite.	9.0
9.	Limestone, tan-gray, aphanitic to fine-grained, pure to highly argillaceous, brittle; small, gray, subspherical to irregular nodules of chert, much of which is stained lavender. Well-preserved *Composita, Pugnoides,* and bryzoa are very common and characterize the unit. At some horizons bryzoa are present in such profusion the rock is given a speckled appearance.	7.5
8.	Limestone, light- to medium-gray, fine- to medium-crystalline, hard, cherty, fossiliferous. Locally the rock is a crinoidal limestone.	39.0
7.	Limestone, argillaceous, much like unit 5 but not quite as argillaceous.	7.0
6.	Limestone, tan-gray, fine- to medium-crystalline, hard, brittle, very fossiliferous; scattered nodules of light gray chert; most fossils are fragments of crinoids, echinoids, bryzoa and brachiopods.	50.0
5.	Limestone, buff-gray, fine-grained, soft, highly argillaceous; chert abundant as irregular nodules, locally comprising as much as 40% of rock; many small vugs lined with secondary calcite or silica; forms slight recess in cliff.	10.0
4.	Limestone, buff-gray, fine-grained to medium-crystalline; fossiliferous; gray chert common as small irregular nodules lined up parallel with bedding; fossils predominantly crinoid fragments, but echinoid spines, bryzoa and *Squamaria ivesi* also common	50.0
3.	Limestone, like unit 2, but much thinner bedded; forms slight recess in cliff which serves as a useful marker.	3.0
2.	Limestone, light-gray, fine- to medium-crystalline; locally coarsely crystalline; recrystalized fragments of crinoids, echinoids, bryzoans, and brachiopods constitute most of the rock; nodules of gray chert locally abundant and lined up parallel with bedding.	46.0
1.	Limestone, light-gray, fine-grained to fine-crystalline; *Squamaria ivesi* very common; abundant chert nodules averaging about three inches in diameter; halo of "cotton rock" around chert nodules gives unit a mottled appearance.	18.0
	Total average thickness of Toroweap Beta Member	239.5

UNIT NO.	DESCRIPTION	FEET
	Toroweap Gamma Member	
6.	Limestone, medium blue-gray, aphanitic to very fine-grained, hard; generally as single angular bed; locally absent.	1.0
5.	Sandstone, buff-gray to yellow, medium- to coarse-grained; well-rounded grains dispersed in silty matrix; thickness somewhat variable.	3.0
4.	Gypstone, like unit 2.	23.0
3.	Dolostone, light buff-gray, fine-grained, thin-bedded; beds angular; scattered nodules of gray chert; some shale partings; persistent in thickness and lithology.	27.0
2.	Gypstone, white, pure to sandy, powdery; locally stained red and yellow; thin lenses of dolostone and impure, fine-grained sandstone. Thickness somewhat variable.	17.0
1.	Sandstone, yellow, medium- to coarse-grained; well-rounded grains in silty to argillaceous matrix; cross-bedded on large and small scale. Locally contains thin beds and lenses of dolostone. Part may be Coconino.	13.0
	Total average thickness of Toroweap Gamma Member	84.0
	Total average thickness of Toroweap Formation	472.2

Conformable and Gradational

COCONINO SANDSTONE

REFERENCES

Darton, N. H.
1910 A reconnaissance of parts of northwestern New Mexico and northern Arizona: U. S. Geol. Surv. Bull. 435, 84 p., 17 pl.

McKee, E. D.
1938 Environment and history of the Toroweap and Kaibab Formations of northern Arizona and southern Utah: Carnegie Institution of Washington Publication no. 492, Washington, D. C., 268 p., illus.

Noble, L. F.
1914 The Shinumo Quadrangle, Grand Canyon district, Arizona: U. S. Geol. Surv. Bull. 549, 100 p., 18 pl.