

**THE ARAPIEN SHALE OF CENTRAL UTAH—A DILEMMA IN
STRATIGRAPHIC NOMENCLATURE**

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ABSTRACT

The Arapien Shale of Middle Jurassic age is widely exposed throughout central Utah. Regrettably, the name "Arapien Shale" is used differently by different groups. U.S. Geological Survey geologists use the name in its original sense: to identify a formation that consists of an upper Twist Gulch Member and a lower Twelvemile Canyon Member. Industry and university geologists use the name as a direct replacement for the term Twelvemile Canyon Member. This dual usage has caused much confusion. In an attempt to resolve this problem, we propose that the Twist Gulch Member be raised to formational rank, that the units now grouped as the Twelvemile Canyon Member be known as the Arapien Shale, and that the name Twelvemile Canyon Member be abandoned. Although this proposal infringes aspects of both the old and new codes of stratigraphic nomenclature, we believe that widespread and common usage argues persuasively for this change.

INTRODUCTION

The name "Arapien Shale" has been used differently by U.S. Geological Survey geologists on the one hand and by industry and university geologists on the other. Geological Survey geologists follow the original definition of the Arapien Shale (Spieker, 1946, p. 123-125): a Jurassic formation that consists of an upper Twist Gulch Member and a lower Twelvemile Canyon Member. Industry and university geologists use the name Arapien Shale as a direct replacement for the name Twelvemile Canyon Member. Much confusion has resulted from this dual usage. This geologic note explains how the confusion arose and proposes a solution to the problem.

HISTORY OF THE NAME "ARAPIEN SHALE"

Early workers commented on the widespread marine beds of Jurassic age in the Sanpete-Sevier Valley area of central Utah (fig. 1). Howell (1875, p. 236) first applied the term "shales" to these beds. Dutton (1880, p. 163) discussed "a narrow belt of rocks of Jurassic age" along the east side of the Sevier Valley between Gunnison and Salina. A half century later, Eardley (1933, p. 330-334), studying the southern Wasatch Mountains, remarked about the great thickness of these rocks, the great masses of evaporites, and the intense deformation (figs. 2 and 3), but none of the early geologists named or defined these units. Finally, in 1946, Spieker (p. 123-125), a longtime principal investigator in the Sanpete-Sevier Valley area, addressed the stratigraphic problem. He named these Jurassic beds the "Arapien shale" and recognized five different lithologic types (table 1). He described these as follows (Spieker, 1946, p. 124):

"there are five different types of lithologic assemblage, in which the order of succession, beginning with the lowermost, is commonly but by no means regularly as follows: (1) Gray limestone, generally thin-bedded; (2) light-gray siltstone and shale, very thin-bedded, with occasional thin beds of finely rippled

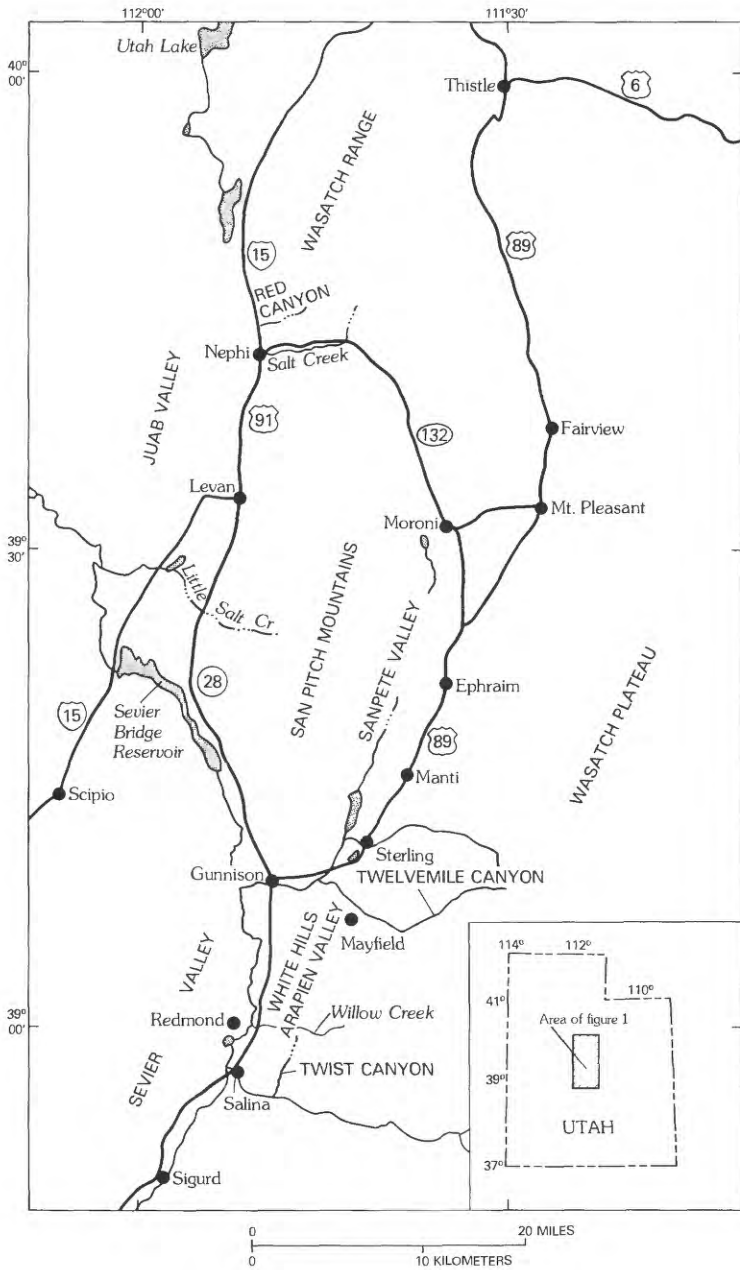


FIGURE 1.--Locations of features mentioned in the text.

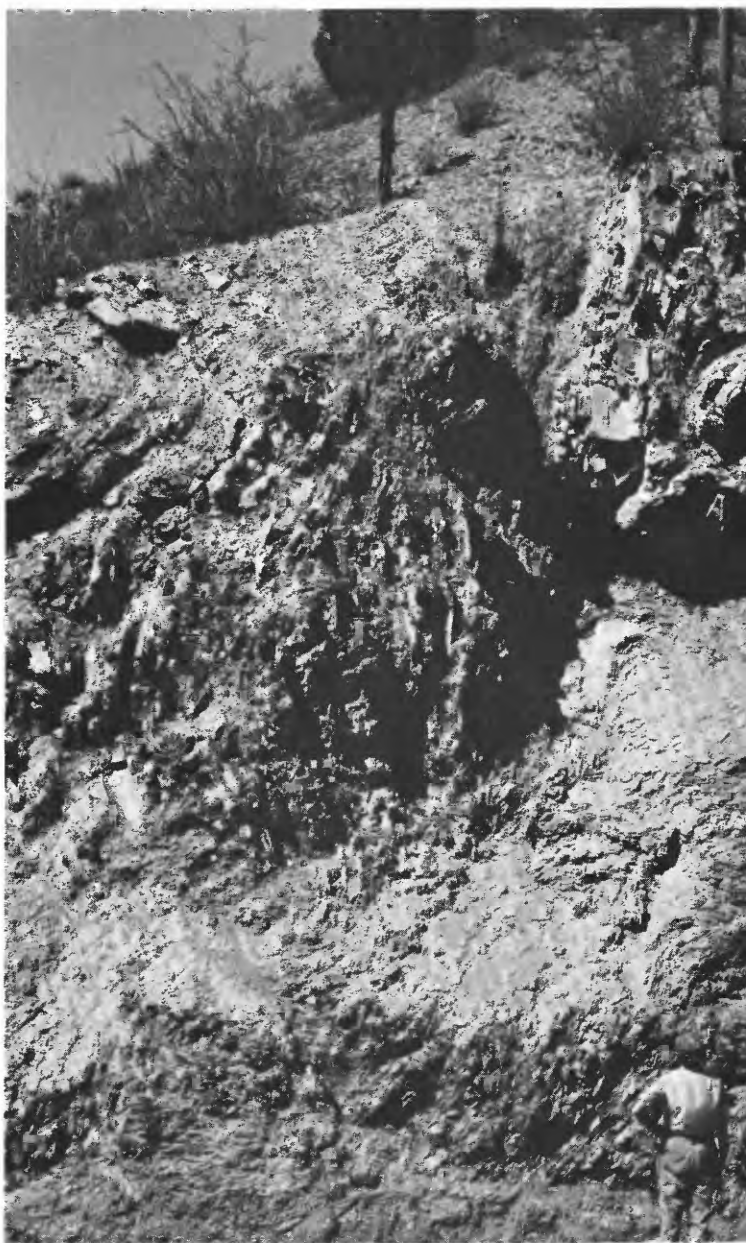


FIGURE 2.—Crumpled, contorted light-gray to gray calcareous mudstone and shaly siltstone beds of the Arapien Shale (formerly called the Twelvemile Canyon Member of Arapien) exposed along the north side of Utah Highway



132 about 5 km east of Nephi. Beds probably correlate with Hardy's unit C. Photograph by T. L. Brown.



FIGURE 3.—Overturned beds of the Arapien Shale (formerly called the Twelvemile Canyon Member of Arapien) exposed along Utah Highway 132 about 6 km east of Nephi. Comparable large-scale deformation is com-



mon throughout the Sanpete-Sevier Valley area. Consequently, thickness measurements of the Twelvemile Canyon Member (Arapien Shale of this report) probably are gross estimates at best.

sandstone; (3) gray shale, argillaceous and gypsiferous, with irregular red blotches, which locally become dominant; (4) compact red salt-bearing shale; (5) thin-bedded red siltstone and shale with many thin layers of greenish white siltstone and occasional zones of gray sandstone, some of which is fairly coarse grained. * * *

Of these five lithologic types, only the uppermost, type 5, can be traced over long distances. Type 5 appeared to Spieker to be sufficiently consistent in lithology and appearance to warrant its being a named member. Therefore, he divided the five types of the Arapien Shale into two members: he named type 5 the "Twist Gulch member" and grouped the remaining four under the name "Twelvemile Canyon member."³

Table 1.--Existing terminology and proposed revisions in stratigraphic nomenclature of the Arapien Shale of Middle Jurassic age
[No lateral equivalency intended]

European stages (Imray, 1980)		Spieker's (1946) original definition		Hardy's (1952) proposed revision		This article	
Middle Jurassic	Callovian	Arapien Shale	Twist Gulch Member	Type 5	Twist Gulch Formation		Twist Gulch Formation
	Bathonian		Twelvemile Canyon Member	Type 4	Arapien Shale	Unit E	Arapien Shale
				Type 3		Unit D	
				Type 2		Unit C	
Type 1	Unit B						
						Unit A	

DESCRIPTION OF THE TWELVEMILE CANYON MEMBER

Bewildering lateral and vertical changes characterize the Twelvemile Canyon Member of the Arapien Shale. To understand these complexities better, Hardy, while he was one of Spieker's graduate students in the late 1940's, did a comprehensive study of the member chiefly where it is exposed along the east side of Sevier Valley. Hardy (1949, 1952) divided Spieker's original four types into five rock units and designated them A through E (table 1). He described these units, from youngest to oldest, as follows (1952, p. 15-16):

Unit E:

Brick-red silty shale, locally salt-bearing. The salt appears to be stratified and commonly contains a considerable amount of red clay.

Unit D:

Alternate layers of bluish-gray and red gypsiferous shale. Blotched appearance of the outcrop due to the lenticular nature of the beds, facies changes, and complex structure.

³The approved geographic name of the type locality of the Twist Gulch Member is "Twist Canyon."

Unit C:

Bluish-gray calcareous shale with gray thin-bedded calcareous sandstone. Several resistant layers of arenaceous limestone with fossils. Massive lenticular beds of gypsum.

Unit B:

Bluish-gray and red gypsiferous shale. Blotched appearance similar to unit D. Red gypsiferous shale in upper part is locally salt-bearing.

Unit A:

Gray shale, gray thin-bedded limestone which weathers brown, red shale, gypsum in thin lenticular beds; or gray thin-bedded argillaceous limestone with massive lenticular beds of gypsum.

In general, unit A consists of Spieker's type 1, B of type 3, C of type 2, D of type 3, and E of type 4. Unit E is locally salt bearing.

These units, too, lack lateral continuity, are very heterogeneous, and range widely in lithology and appearance.

Although Howell (1875, p. 236), Richardson (1907, p. 8, 9), Spieker, and Hardy, among others, referred to some of these rock types as shales, almost none are shale in the commonly accepted sense (paper-thin laminae); most of the units are probably best described as calcareous mudstones. Picard (1980, p. 137) refers to the bulk of them as "micrite or clayey micrite."

No complete section of the Twelvemile Canyon Member is exposed anywhere in central Utah. Consequently, a specific type locality was not designated by Hardy.

Previous workers (Picard, 1980, p. 131; Spieker, 1949, p. 17; Moulton, 1977, p. 9) have suggested that the "Arapien shale" (that is, the Twelvemile Canyon Member) rests on the Navajo Sandstone, to which they assigned a Jurassic age. In Red Canyon, near Nephi, the Twelvemile Canyon Member is separated from the Navajo Sandstone by a series of beds, chiefly carbonate rock, that correlate with the lower and medial parts of the Middle Jurassic Twin Creek Limestone. The intercalated sequence includes the Gypsum Spring, Sliderock, Rich, Boundary Ridge, and Watton Canyon Members of the Twin Creek. This Gypsum Spring-Watton Canyon sequence of beds, separating the Twelvemile Canyon Member from the Navajo Sandstone, has been repeatedly cut by exploratory wells drilled by Placid Oil Company in the Juab and Sevier Valleys (Sprinkel, 1982). The Twelvemile Canyon Member most likely rests on one or another of these members of the Twin Creek Limestone throughout the Sanpete-Sevier Valley area.

A variety of units overlies the Twelvemile Canyon Member. In places, the Twelvemile Canyon Member is overlain with gradational contact by the Twist Gulch Member, but locally, as a result of either strip-thrusting (Billings, 1933) or sedimentary intrusive action (Witkind, 1982), the Twelvemile Canyon Member is overlain by beds of the Green River Formation (Eocene).

The Twelvemile Canyon Member is so severely deformed that its original thickness cannot be determined; estimates range from 1,220 to 3,960 m (Spieker, 1949, p. 17; Gilliland, 1948, p. 30; Hardy, 1949, p. 16, 17).

THE PROBLEM

During the course of his work, Hardy became convinced that the Twist Gulch and the Twelvemile Canyon Members were sufficiently distinct and widespread to warrant separate formational status. Spieker agreed, and consequently Hardy (1949, p. 8) noted: "* * * The nomenclature of the strata included in the Arapien shale by Spieker has recently been modified by Hardy and Spieker in order to set apart the Arapien and the Twist Gulch as separate formations (Hardy and Spieker, in preparation). * * *"

Hardy (1952, p. 14) subsequently reemphasized his and Spieker's general views:

"* * * The Arapien shale was defined by E. M. Spieker in 1946, as a formation with two distinct members (Spieker, 1946, pp. 123-125). The term is now restricted to the strata formerly included in the Twelvemile Canyon member, and the Twist Gulch member is redesignated as a formation because of its great areal extent in central Utah (Hardy and Spieker, in preparation). * * *"

The Hardy-Spieker paper referred to in the above quotations was never published, but most subsequent authors seemingly assumed that the paper was in print, or simply accepted the reasonableness of Hardy's proposal, and used the term "Arapien shale" in a formational sense, much as proposed by Hardy, and as an exact replacement of the name "Twelvemile Canyon Member."

Hardy's redefinition of the Arapien Shale now infringes article 19 of the North American Stratigraphic Code (North American Commission on Stratigraphic Nomenclature, 1983), which forbids using an original name for any of its divisions. In essence, the original name "Arapien shale" should not be employed for one of its divisions—the Twelvemile Canyon Member. As matters now stand, the term "Arapien Shale" has been and is being used in its original sense by some authors (Imlay, 1980; Witkind, 1982, 1983) and in its restricted sense by others (Moulton, 1977; Baer, 1976; Picard, 1980). Authors, therefore, are obliged to specify exactly what they mean by the term "Arapien Shale" if they are not to confuse their readers.

DISCUSSION AND PROPOSED SOLUTION

Dual usage of the term "Arapien Shale" should not continue. For 30 years most geologists have followed Hardy's redefinition of the Arapien Shale. Of some 25 significant papers dealing with the geology of the Sanpete-Sevier Valley area, 17 have conformed with Hardy's usage. Only a handful of authors, chiefly U.S. Geological Survey geologists (Imlay, 1964, 1967, 1980; Witkind, 1982, 1983), have followed Spieker's original usage.

The inherent logic of dividing the Jurassic marine strata of central Utah into the Twist Gulch Formation and the Arapien Shale is widely accepted, and most authors now use Hardy's revision. Although Hardy's redefinition of the name Arapien Shale violates the present code, his redefinition is entrenched in the literature, is widely used, and is unlikely to be dislodged.

The fact that Hardy's definition violates the code does not necessarily make it unacceptable. A few examples of comparable but generally accepted breaches of the stratigraphic code are listed in table 2. Many more could be cited. These examples demonstrate that long established common usage is a valid criterion for the formal acceptance of stratigraphic names.

Because the name "Arapien Shale" has become entrenched in the literature in its restricted sense as a substitute for the formal name "Twelvemile Canyon Member of the Arapien Shale," we recommend that the original Arapien Shale be divided into an upper Twist Gulch Formation and a lower Arapien Shale, and that the name Twelvemile Canyon Member be abandoned (table 1).

Table 2.—Examples of commonly accepted stratigraphic names that violate the stratigraphic code

[Source: M. E. Mac Lachlan, U.S. Geological Survey Geologic Names Committee Representative, written commun., 1982]

Name	Code violation	References
Wingate Sandstone	Sandstone at type locality (Fort Wingate, New Mexico) is Entrada Sandstone, not Wingate.	Harshbarger and others (1957, p. 8); Green (1974, p. D10).
Ocate Sandstone	Abandoned by U.S. Geological Survey, but still widely used in published literature.	Lessard and Bejnar (1976, p. 105).
Mesaverde Formation	Used for more than 70 years, in northwestern Colorado, eastern Utah, and southwestern Wyoming, for beds unlike those of the type section.	Gill and others (1970, p. 5).
Ojo Alamo Sandstone	In San Juan Basin, New Mexico, name has been used so commonly and consistently for beds now known to be Paleocene that the beds of the original type section (Cretaceous) have had to be excluded.	Brown (1910, p. 268); Baltz and others (1966, p. D14).

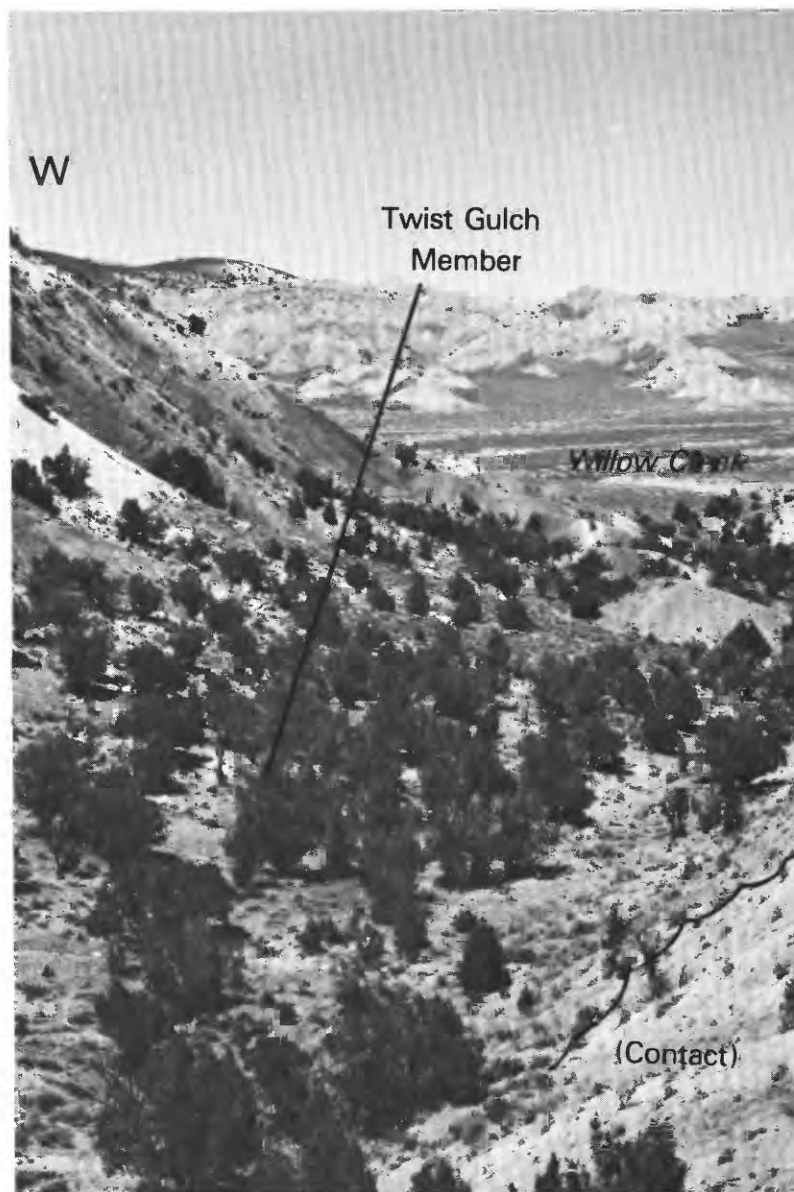


FIGURE 4.--View northward of the intricately dissected badland topography developed on the calcareous mudstones of the Arapien Shale (formerly called Twelvemile Canyon Member of Arapien) as exposed in the White Hills near Willow Creek, some 8 km northeast of Salina. Beds are part of Hardy's unit D—light-gray beds mottled irregularly with patches of light



red. Darker beds along left side of photograph are reddish-brown shaly siltstones and sandstones of the Twist Gulch Formation (formerly called Twist Gulch Member). Light-colored cap on ridge (near right side of photograph) consists of light-brown limestone fragments of the Green River Formation of Eocene age. Photograph by T. L. Brown.



FIGURE 5.—Vertical, interlayered, and much contorted dark reddish-brown amorphous mudstones and thin salt beds characteristic of Hardy's unit E of the Twelvemile Canyon Member (Arapien Shale of this report). Exposure is near Redmond. Beds of salt, as much as 60 m thick, are mined from these strata in this area.

**PRINCIPAL REFERENCE LOCALITY,
ARAPIEN SHALE**

Most of the units that make up the Twelvemile Canyon Member crop out in several widely separated areas, and one of these areas is here designated as a principal reference locality of the Arapien Shale. This principal reference locality extends along the east flank of Sevier Valley as a belt 3 to 5 km wide and about 45 km long, from near Sigurd on the south to Sterling on the north. Hardy's units B through D are particularly well exposed in the White Hills, a range of low hills adjacent and parallel to the Arapien Valley near Mayfield (fig. 4). Unit E (red silty shale) is exposed about 8 km west of this belt near Redmond (fig. 5). Unit A (thin-bedded limestone) is not exposed in this reference locality of the Arapien.

A second area where Spieker's Twelvemile Canyon Member is well exposed is here designated a reference locality of the Arapien. This locality extends along the west and north flanks of the San Pitch Mountains and forms a belt, about 3 km wide and 30 km long, from near Little Salt Creek on the south to Salt Creek on the north. Limestone beds (unit A) are part of these exposures, but it is uncertain whether these limestone beds should be assigned to the Arapien or to the Twin Creek Limestone.

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CONTRIBUTIONS TO STRATIGRAPHY

GEOLOGICAL SURVEY BULLETIN 1537-A

Seven short papers describe changes in stratigraphic nomenclature in Alaska, Utah, New Mexico, North Carolina, South Carolina, Puerto Rico, and eastern North America; geologic time chart revised.

