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James E. Fassett

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GEOLOGY OF THE POINT LOOKOUT, CLIFF HOUSE AND PICTURED CLIFFS SANDSTONES OF THE SAN JUAN BASIN, NEW MEXICO AND COLORADO

JAMES E. FASSETT
U.S. Geological Survey
Farmington, New Mexico

INTRODUCTION

The San Juan Basin is located in northwest New Mexico and southwest Colorado, near the common corner of New Mexico, Arizona, Utah and Colorado (fig. 1). The basin is a northwest-trending asymmetric structural depression; around the east, north and northwest parts of the basin; rocks dip steeply, whereas, along the west and southwest flanks of the basin, dips range from less than 1° to 3°.

The purpose of this paper is to discuss the subsurface geometry of the Upper Cretaceous Point Lookout and Cliff House sandstones (including several named and unnamed tongues) of the Mesaverde Group and the Pictured Cliffs Sandstone. The physical configuration of these rock units is related to their environments of deposition, and some of the nomenclature problems associated with the Cliff House Sandstone transgression are discussed. No attempt is made in this report to formally revise the nomenclature of the rock units.

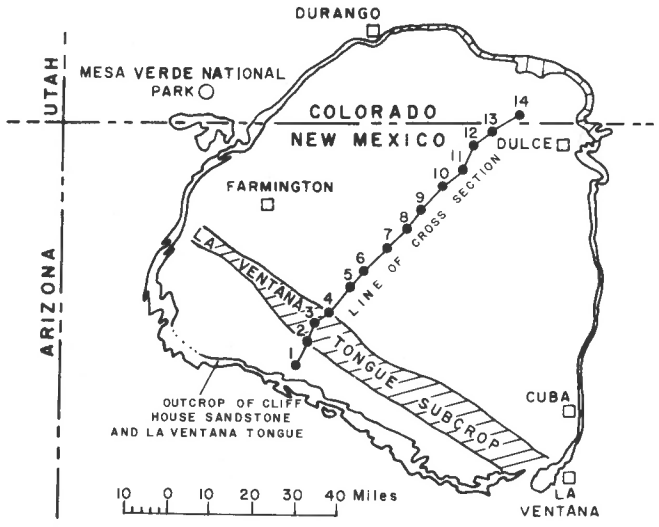


Figure 1. Index map showing the location of the San Juan Basin as defined by the outcrop of the Cliff House Sandstone (including the La Ventana Tongue). The hachured outcrop between Durango, Colorado, and Dulce, New Mexico, is the undivided Mesaverde Group. The dotted upper contact in the southwest part of the basin is where the Pictured Cliffs Sandstone and the Cliff House Sandstone have merged. Numbered points along the line of cross section are wells, the logs of which are shown on Figure 2. The La Ventana Tongue subcrop band is that area underlain by the La Ventana Tongue of the Cliff House Sandstone.

GEOMETRY OF THE POINT LOOKOUT, CLIFF HOUSE AND PICTURED CLIFFS SANDSTONES

Figure 2, a northeast-trending, subsurface, stratigraphic cross section clearly illustrates the geometric configuration of the Point Lookout Sandstone, Cliff House Sandstone (and included tongues), and Pictured Cliffs Sandstone of the San Juan Basin. The Huerfanito Bentonite Bed of the Upper Cretaceous Lewis Shale (Fassett, 1971) is used as a datum. Because this bed was deposited as an instantaneous geologic event on a nearly flat surface, using it as a datum should portray the regressive and transgressive sandstones close to their original attitudes after deposition but before any deformation (with the exception of differential compaction). The geophysical logs used for control on this section are more or less evenly spaced across the basin and average about 6 miles (10 km) apart; these logs are listed in Table 1. The cross section is oriented at right angles to the average shoreline trend throughout the time that the rock units portrayed were being deposited.

At first glance, one notices that the configuration of the Point Lookout Sandstone and the Pictured Cliffs Sandstone on Figure 2 is remarkably similar. Both units rise to the northeast in a series of steps. The rise of the top of the Point Lookout Sandstone is 970 ft (296 m) between wells 1 and 14; the top of the Pictured Cliffs Sandstone rises 1,026 ft (313 m) between wells 2 and 14, representing a difference between the two of only 56 ft (17 m). Upon closer examination, however, it is seen that most of the stratigraphic rise of the Point Lookout occurs between wells 4 and 9, whereas the Pictured Cliffs has a more even rise across the basin, except for the abrupt rise between wells 9 and 12.

The geometry of the Cliff House Sandstone is quite different from that of the Point Lookout and Pictured Cliffs sandstones. The Cliff House consists of a few thick sandstone lenses at the base, irregularly dispersed along a surface that rises gently to the southwest. This surface, represented by the contact between the Lewis Shale and Upper Cretaceous Menefee Formation of the Mesaverde Group in those areas where the Cliff House is absent, rises only 38 ft (12 m) from well 14 to well 3. In this report, this part of the Cliff House Sandstone will be referred to as the basal Cliff House Sandstone.

In the southwest part of the basin, the thick, massive La Ventana Tongue of the Cliff House Sandstone occurs above the basal Cliff House Sandstone. At well 3 the La Ventana is 610 ft (186 m) thick, with a 70-ft (21-m) thick shale break separating it from the underlying basal Cliff House Sandstone. To the northeast the La Ventana interfingers with the Lewis

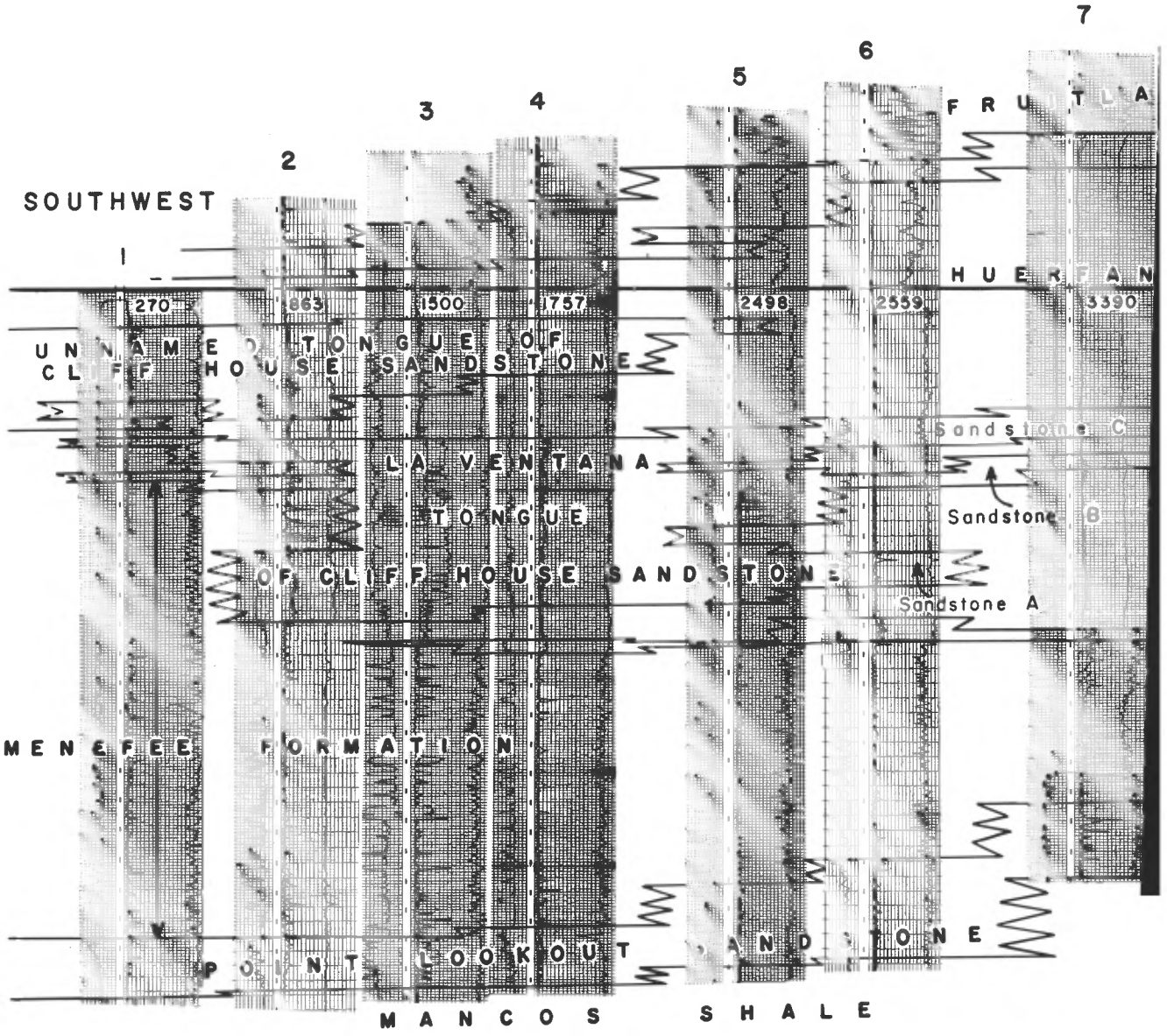
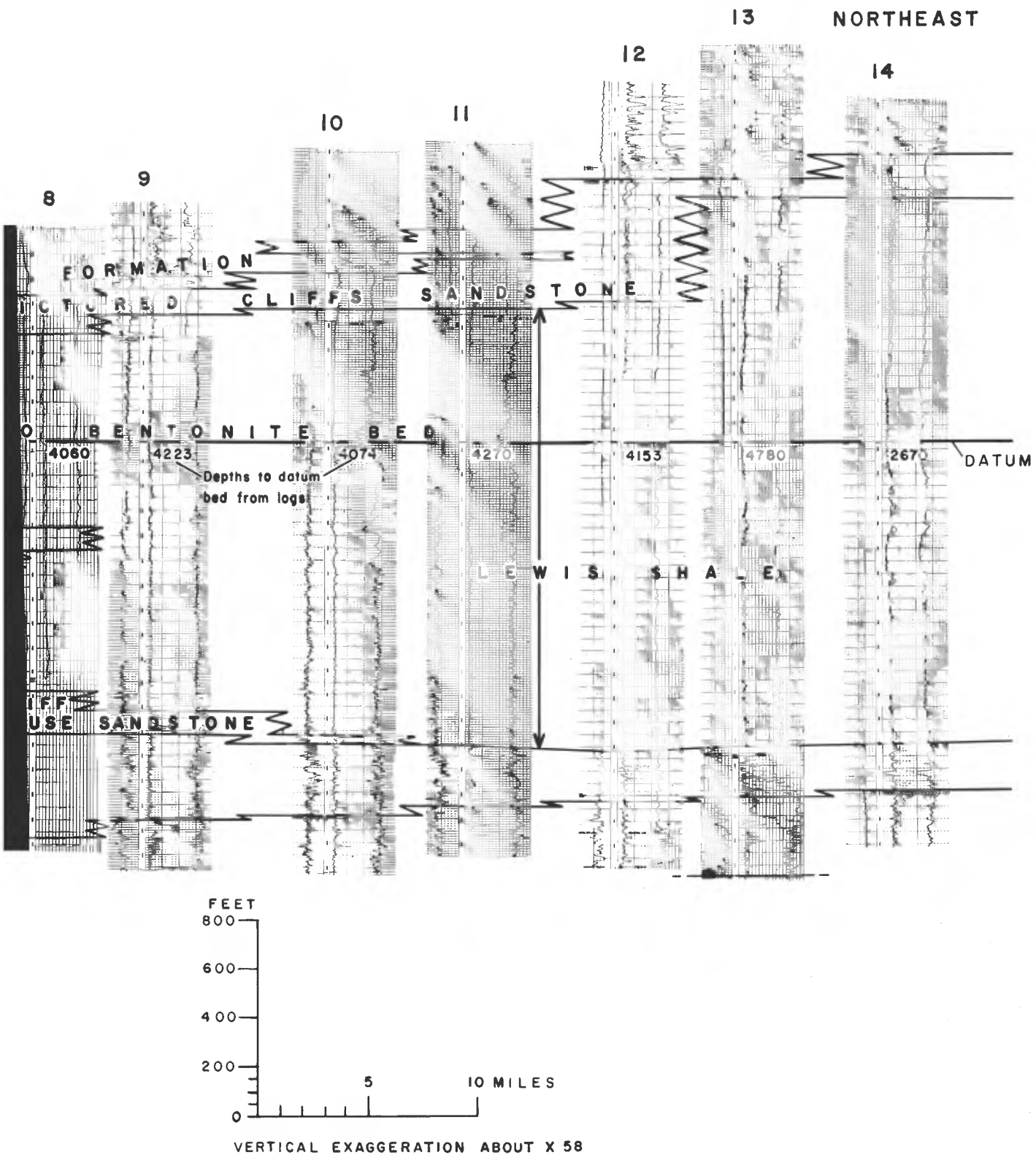


Figure 2. Stratigraphic, subsurface cross section across the San Juan Basin.



Line of section shown on Figure 1. The wells used for control are listed in Table 1.

Table 1. List of Wells on Southwest-Northeast Cross Section (fig. 2)

(Kind of log used: IE, induction-electric; E, electric. Elevation, in feet, at well (Kelly Bushing)

Well No.	Company	Well name	Location Sec.	T.N.	R.W.	Kind of log used	Elevation (feet)
		New Mexico					
1	Humble Oil and Refining Co	Tanner Unit Z	23	23	12	IE	6034
2	Magnolia Petroleum Co	Beamon Federal 1	29	24	11	E	6251
3	Davis Oil Corp	Fannin Govt. 1	3	24	11	IE	6590
4	Sun Oil Co	Heirs of Ith-Hal-E-Wood 1	19	25	10	IE	6583
5	El Paso Natural Gas Co	Huerfano 120	25	26	10	IE	6629
6	Turner and Webb	Huerfanito 60-4	4	26	9	IE	6406
7	El Paso Natural Gas Co	Schwerdtfeger 13-A	8	27	8	E	6745
8	... do	San Juan 28-7 30	18	28	7	E	6871
9	... do	San Juan 29-7 65	22	29	7	E	6781
10	... do	Barron Kidd 7	21	30	6	E	6457
11	... do	Rosa Unit 24	32	31	5	E	6528
12	Stanolind Oil and Gas Co	San Juan 32-5 2	35	32	5	E	6336
13	Phillips Petroleum Co	Mesa 32-4 2-16	16	32	4	E	6808
		Colorado					
14	Stanolind Oil and Gas Co	Southern Ute 1	22	32	3	E	7188

Shale, and the last tongue, sandstone C, pinches out between wells 8 and 9. To the southwest the La Ventana fingers out into the Menefee Formation, and only a few thin tongues are left at well 1.

Above the La Ventana, but not physically connected to it on this section, occurs an upper unnamed tongue also of the Cliff House Sandstone. This unit extends northeastward as far as well 5 and southwestward beyond the limits of this section; it reaches a maximum thickness of 320 ft (98 m) at well 2. At this well, the upper unnamed tongue of the Cliff House is only 160 ft (49 m) beneath the base of the overlying Pictured Cliffs Sandstone. The total stratigraphic rise of the top of the Cliff House Sandstone between wells 10 and 1 is 1,065 ft (225 m).

Between the above described sandstone units are the Menefee Formation and the Lewis Shale. Each is wedge-shaped; the continental, coal-bearing Menefee thins northeastward from 1,550 ft (472 m) to 185 ft (56 m), whereas the marine Lewis Shale thins southwestward from 2,300 ft (701 m) to 160 ft (49 m).

NOMENCLATURE OF THE CLIFF HOUSE SANDSTONE

Of the three sandstone units discussed in this report, only the Cliff House Sandstone has been the object of any continuing nomenclatural controversy. The unit was first described by Holmes (1877), who defined the Mesaverde Group at its type locality in Mesa Verde National Park. Holmes divided the Mesaverde into three units called the Lower Escarpment Sandstone, Middle Coal Group and the Upper Escarpment Sandstone. Collier (1919, p. 297) later named these three units the Point Lookout Sandstone, the Menefee Formation and the Cliff House Sandstone, respectively. The Cliff House name of course, was derived from the many prehistoric cliff dwellings located on this unit in the Mesa Verde National Park area.

In 1936, Carle Dane described the geology and coal deposits of the southeastern part of the San Juan Basin. In his report, Dane defined the La Ventana Sandstone and the Chacra sandstone members of the Mesaverde Formation. Dane's original La Ventana sandstone member was named for the village of La Ventana (fig. 1), in the southeast part of the basin, and is the outcrop equivalent of the massive sandstone unit of the same name shown in Figure 2. The Chacra sandstone member of Dane, named for Chacra Mesa, is the outcrop equivalent of the unnamed sandstone tongue of the Cliff House shown on Figure 2. Dane's report included a geologic map of the area from just east of La Ventana and Cuba northwestward along the Cliff House outcrop for a distance of about 50 miles (80 km) (fig. 1). Northwest of the break in the outcrop in the southeast part of the basin (fig. 1), the unit was mapped by Dane as the Chacra sandstone member; east of this break to just east of Cuba, the unit was mapped as the La Ventana sandstone member.

Over the next two decades, the entire outcrop band of the Cliff House Sandstone was mapped around the basin rim: From Mesa Verde National Park south and southeastward, and from Mesa Verde National Park northeastward to Durango, Colorado, it was mapped as Cliff House Sandstone; east from Durango to near Dulce, New Mexico, the Cliff House Sandstone was not mapped separately but was included in the undivided Mesaverde Group; and from Dulce to Cuba, New Mexico, the unit was mapped as La Ventana Sandstone Member of Mesaverde Formation. Later, Beaumont and others (1956) abandoned the name Chacra sandstone member in favor of Cliff House Sandstone and changed the name La Ventana sandstone member to La Ventana Tongue of the Cliff House Sandstone.

Over the following two decades, other new names were applied to various parts of the Cliff House. (As illustrated on Figure 2, many tongues of sandstone and shale are associated with the Cliff House, Lewis Shale and Menefee Formation, and the compulsive splitter of rock units could apply a name to each of them.) The most serious problem is the misuse of the name "Chacra" for sandstones B and C of Figure 2; this name was applied because these sandstone units were found to contain natural gas in parts of the San Juan Basin, and oil-and-gas company geologists informally labeled them "Chacra." Credit (or blame) for this naming remains vague. The New Mexico Oil Conservation Commission is considering the formal adoption of the term "Chacra producing interval"

for a zone that extends from 750 ft (229 m) below the Huerfanito Bentonite Bed to the Huerfanito.

The author and others had earlier suggested that Dane's original definition of the Chacra sandstone member be restored to those outcropping rocks in the southern San Juan Basin equivalent to the upper unnamed tongue of the Cliff House Sandstone of Figure 2; however, with the name "Chacra" now being used informally for the subsurface sandstones B and C of the La Ventana Tongue, a new name seems desirable for this overlying upper, unnamed tongue of the Cliff House Sandstone. The name Tsaya Canyon sandstone tongue of the Cliff House Sandstone should be considered for this unit, because it is particularly well exposed in Tsaya Canyon in the southwest part of the basin. (This name is not formally recommended here as guidebooks are not appropriate places to make formal nomenclature changes.)

The above discussion is far from a comprehensive treatment of the nomenclatural problems connected with the Cliff House Sandstone, but it will introduce field trip participants and other users of this guidebook to the problems.

ENVIRONMENTS OF DEPOSITION OF THE POINT LOOKOUT, CLIFF HOUSE AND PICTURED CLIFFS SANDSTONES

The littoral marine sandstone units discussed herein clearly represent three major cycles of regression-transgression-regression of part of the shoreline of the western interior seaway during Late Cretaceous (late Campanian) time. Both the Point Lookout and the Pictured Cliffs sandstones were deposited during regression of the Cretaceous sea, whereas the Cliff House represents—at least in an overall sense—a transgressive episode.

The strandline fluctuations which resulted in deposition of these units across the SCI-SWO ("sea-came-in, sea-went-out") zone (Fassett, 1974) on the west edge of the epicontinental seaway have been discussed frequently in papers over the past 36 years. The first paper, by Sears and others (1941), suggested that the transgressive-regressive deposits of the basin were created in a slowly subsiding trough and that the movements of the shoreline resulted from changes in the rate of sediment influx. Subsequent work confirmed this hypothesis. Thus, the Point Lookout and Pictured Cliffs regressions (fig. 2) occurred when sediment influx exceeded the rate of subsidence.

During Cliff House time a series of three distinct events probably occurred, as indicated by the geometry of this unit shown on Figure 2: First, there was a fairly rapid transgression of the sea from the position of well 14 to well 3, as evidenced by the scarcity of sandstone on top of the Menefee Formation and by the small amount (38 ft or 12 m) of stratigraphic rise of this unit (basal Cliff House Sandstone) between these two points. This episode reflects a very low rate of sediment influx in to the sea at that time. Second, the geographic position of the shoreline stabilized near wells 2 through 5, when the rate of sediment influx increased until it nearly equaled the rate of basin subsidence. Minor regressions of the sea are reflected by sandstones A, B and C. Minor transgressive pulses are indicated by the sandstone tongues extending from the La Ventana into the Menefee Formation to the southwest. Third, a period of less sediment influx resulted in a rapid transgression to the southwest, as evidenced by the gap between the La Ventana and the unnamed tongue of the Cliff House, followed by a period of regression and stabilization of the shoreline over the area from wells 1 through 4; and then a final transgression that carried the shoreline to the southwest beyond the limits of this cross section. This third episode caused deposition of the unnamed sandstone tongue of the Cliff House Sandstone.

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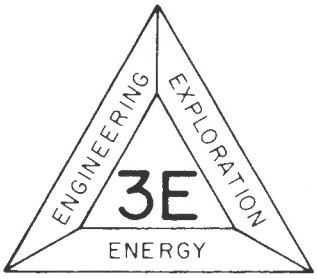
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