AN UNCONFORMITY BOUNDARY EXPOSED AT THE LOWER TORNILLO CREEK BRIDGE, BIG BEND NATIONAL PARK, BREWSTER COUNTY, TEXAS, U.S.A.

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Abstract

An outcrop along lower Tornillo Creek provides an unconformity contact between the San Vincente Member of the Boquillas Formation and the overlying Pen Formation. This contact marks the depositional boundary between the former North American epeiric seaway (actually retreating Floodwater) and subaqueous caldera erupted sediments derived from the Trans-Pecos Texas region. A source for the Pen Formation sediments along with a mechanism for mixing the marine fossils found within it is proposed within the framework ***of*** *the Young-Earth Flood Model.*

Introduction

Much work has been conducted in Big Bend National Park in an effort to interpret the physical evidence (i.e., sediments, fossils, and volcanic features) within the framework of the Young-Earth Flood Model (e.g., Williams and Howe, 1993; Williams, Matzko, Howe, White, and Stark, 1993; Williams, 1993a, 1993b; Froede, 1995a, 1995b, 1996). The Park provides many interesting geologic exposures which span the Mesozoic (i.e., Late Cretaceous) to Holocene. This paper explains the lower Tornillo Creek area strata (i.e., sediments and fossils) within a creationist geological timescale (Froede, 1995c).

Site Location

The site of interest is located on the northeastern side of the Tornillo Creek Bridge (Figure 1). This particular exposure contains an interesting contact between the San Vincente Member (Mbr) of the Boquillas Formation (Fm) and the overlying Pen Fm [Maxwell, Lonsdale, Hazzard, and Wilson, 1967, p. 30]. For many localities the San Vincente Mbr grades upward into the Pen Fm, while at others the contact is abrupt (Maxwell et al., 1967, p. 67). This specific locale reflects an abrupt contact (i.e., unconformity). Both of these stratigraphic units are regarded by Uniformitarians as being Upper Cretaceous due to the fossils which they contain (reflecting circular reasoning-see Froede, 1994).

Site Stratigraphy

The Cretaceous age deposits in the Park, are viewed as reflecting the transition from a warm shallow epeiric seaway to terrestrial surfaces where the dinosaurs roamed (these environmental changes supposedly occurred over the course of millions of years during the Late Cretaceous). A Young-Earth creationist interpretation of the epeiric sea as regressing Floodwater is presented in Froede (1995d).

The difference between the San Vincente Mbr and the overlying Pen Fm is recognized as being both lithological

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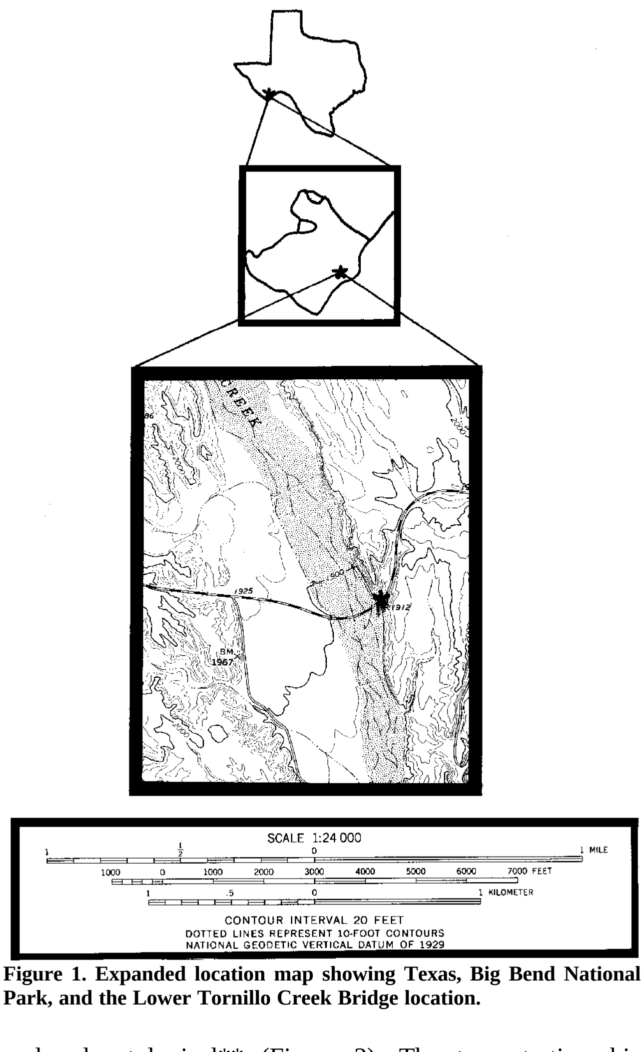

Figure 1. Expanded location map showing Texas, Big Bend National Park, and the Lower Tornillo Creek Bridge location.

and paleontological** (Figure 2). The two stratigraphic units have been investigated and described by Maxwell et al., (1967) as:

**The paleontological tools identified as "Inoceramus" and "Exogyra" are varieties of oysters which were present during the Cretaceous but have since become extinct. They are recognized as "index fossils" and are key to the identification and dating of strata based on the uniformitarian concept of biostratigraphy.

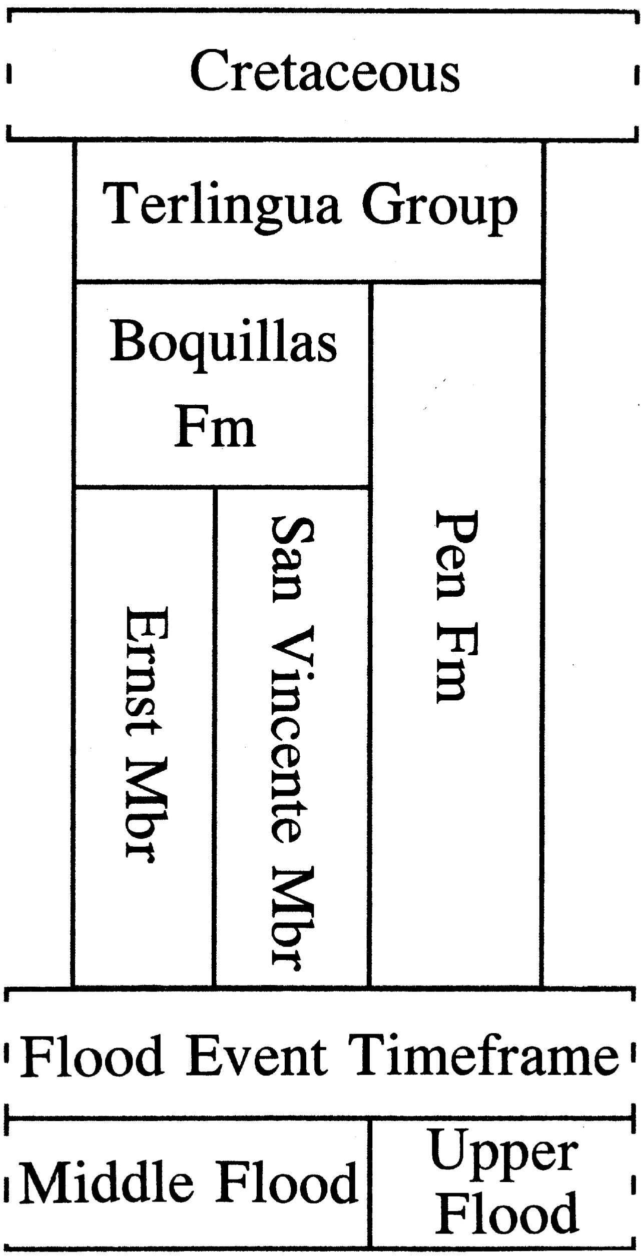

Figure 2. A generalized uniformitarian stratigraphic column (modified and redrawn from Runkel, 1989, p. 124, Figure 3) compared to a proposed generalized creationist stratigraphic column (Froede, 1995c). The boundary separating the Middle and Upper Flood Divisions should be located at this point due to overlying Aguja and Javelina Fm deposits exhibited in other sections of the Park.

Boquillas Formation

San Vincente Member-The member is mostly 350 to 400 feet thick but thins in some places to 130 feet. It is composed of gray, thin- to medium-bedded, chalky and argillaceous limestone flags interbedded with gray or yellowish-gray platy marl or soft gray marl. The amount of flagstone decreases upward, and the top of the member is alternating soft gray marl and chalk. A chalky ledge (usually a low cuesta) 15 to 20 feet below the top of the San Vincente contains abundant *Inoceramus undulatoplicatus.* Above the *Inoceramus undulatoplicatus* beds, as much as 22 feet of gray marl, slightly indurated, with some flagstone, contain numerous large *Inoceramus* sp. In most localities the San Vincente grades upward into the Pen Formation, but in places the contact is abrupt. At several places, especially in the Terlingua area, the uppermost San Vincente Member is shaly, slightly sandy, and dark gray. These dark beds are slightly more resistant to erosion than the gray-white chalk and weather into lenticular mounds, 10 to 20 feet in diameter and 5 to 6 feet high (pp. 64-67). [Figures 3, 4, and 5 illustrate this description]

Figure 3. The eroded top surface of the San Vincente Mbr. Cracks form along joints which run parallel to Tornillo Creek. In the approximate lower center portion of the picture there is the remains of a large weathered *Inoceramus* sp. (dark area is shell-light area is limestone)

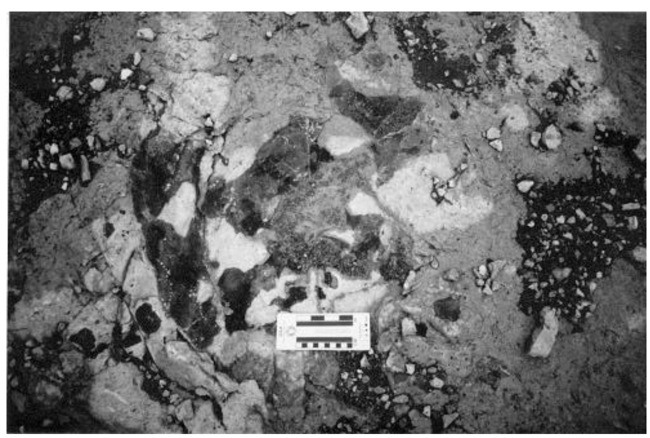

Figure 4. A weathered *Inoceramus* sp. along the top surface of the San Vincente Mbr. The small circular features on the shell are rasping holes created by one or more boring organisms (e.g., sponge, worms, algae, and/or other mollusks) [dark area is shell-light area is limestone]. These features. indicate age and require a once living creature to have lived for a period of time. Hence, this creature was living in the North American epeiric seaway and was washed into the Big Bend area and buried under volcaniclastic sediments during the Middle to Upper Flood Event Divisions.

Figure 5. Abrupt contact between the Pen Fm (gray to black clays) and the underlying San Vincente Mbr (white to light gray limestone). Scale in center of picture is 6.5 inches long. Note the calcareous clay transition just above the massive limestone contact. This transition zone weathers at the same rate as the Pen Fm. These lighter clays were derived from sediments transported from the submerged North American interior.

Pen Formation - The Pen Formation is 219 to about 700 feet thick in the Park. Although there are many local variations, the Pen Formation generally thickens from **southeast to northwest across the Park.** Its total thickness is readily determined, but because of the extensive alluvial cover, it is usually difficult to determine individual units. The basal 50 feet is normally calcareous clay, light bluish gray, with one inch beds of gray chalk. Above this is yellow clay with scattered sandy beds in which some concretions are in beds and others are irregularly distributed. The formation is soft and less resistant to erosion than either the San Vincente below or the Aguja above, and it forms a belt of low topography. Badlands occur in some places, but where indurated terrace gravels cap the clay, the formation stands in steep-faced slopes and some of its unprotected surfaces are low and are subject to sheet wash (pp. 71-73, 78). [Figures 5, 6, and 7 illustrate this description].

Concretions are common throughout, most of which are calcareous, although some are clay-ironstone. Most of the concretions are disc-shaped and are as much as 4 feet in diameter. Most of them are scattered in the clay, but some form layers which extend for several miles. Many of the concretions are cracked and filled with siltstone or thin bands of dark calcite. Layers with numerous concentrations are mostly sandy, and commonly the concretions are encrusted by sandstone.

Of the fossils common to the Pen Formation, *Exogyra ponderosa* is the most abundant.*** It ranges from the base of the formation into the Aguja. It is especially abundant in the concretionary beds, and at one place in the north bank of Tornillo Creek, about a mile above the lower bridge, it is an important rock constituent in a 10-foot interval. (boldface mine)

***Many other invertebrate fossils are found in the Pen Fm, including gastropods, ammonites, and pelecypods. A comprehensive listing can be found in Maxwell et al., (1967, p. 78).

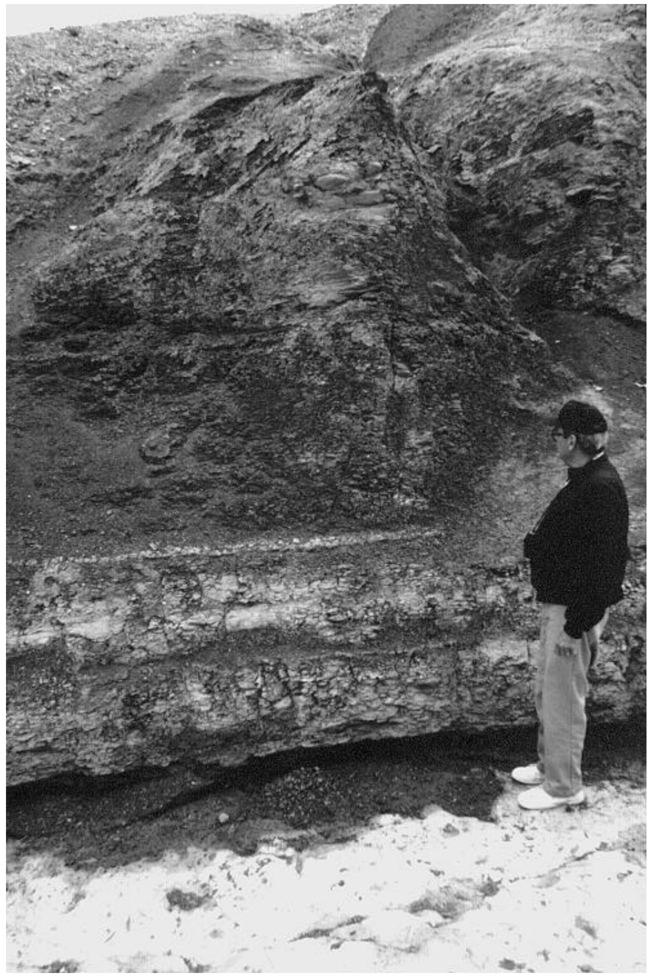

Figure 6. Contact between the San Vincente Mbr and the overlying Pen Fm. Note concretions at several layers along with distinct light clay layers. Undercutting of the soft Pen Fm clay is accomplished as surface waters drain from the sloped San Vincente Mbr toward Tornillo Creek.

What is interpreted to be a conformable contact between the San Vincente Mbr (Boquillas Fm) and the overlying Pen Fm is commonly placed at the top of the progressively thinner bedded limestone which contains very large Inoceramus invertebrate shells (Maxwell et al., 1967, p. 75; Scheubel and Mruk, 1994, p. 29; Stevens and Stevens, 1989a, p. 24). However, many outcrops of this specific type of contact are not so easily discernible. According to Stevens and Stevens (1989a, p. 24):

The *I. undulatoplicatus* Zone occurs at Chisos Pen east of Terlingua and north of the Chisos Mountains, but not in the Terlingua area; however, there is a widespread thin-bedded limestone unit . . . This limestone contains

Figure 7. Closeup of the massive clays of the Pen Fm. Both vertical and horizontal joints were noted. Scale is in inches (right) and centimeters (left).

> possible *I. platinus* and **storm generated shell fragment rudstones.** Lehman (1985) placed the *I. platinus* Zone within the Pen Formation near the base. (emphasis mine)

Due to the variation in both the lithologic and paleontologic materials associated with the "type conformable contact" between the San Vincente Mbr and the Pen Fm, the exact boundary is in many locations speculative. More importantly: **The nature of the contact is based on the paleontology, not on the change in lithology.** Limitations in the lateral extent of these specific strata also serve to poorly define this contact.

Paleoenvironments

The San Vincente Mbr of the Boquillas Fm reflects a marine depositional environment, due to both its lithologic (i.e., calcareous clay and marl) units and marine invertebrate fossils (see Maxwell et al., 1967, pp. 70-71). This stratigraphic member is suggestive of the epeiric seaway (i.e., retreating Floodwaters) marine environment. The cyclical nature of some of the calcareous layers containing a mixed variety of invertebrates in non-life position interbedded with calcareous marl is suggestive of storm event deposition (Einsele, 1992, p. 309). However, others suggest that it reflects Milankovitch cycles**** and diagenetic alteration (Einsele and Ricken, 1991; Stevens, and Stevens, 1989a, p. 24).

The Pen Fm is in total contrast, both lithologically and paleontologically, to the underlying San Vincente Mbr. Maxwell et al., (1967, p. 96) suggested that the differences in the lithology between the Pen and San Vincente reflect:

> . . . tectonic movements (which) began as early as the time of deposition of the San Vincente Formation [sic] and increased in intensity and magnitude to the end of the epoch . . . The pre-Tertiary surface was progressively overlapped by the Tertiary rocks from **southeast to northwest across the Park.** (parenthesis and emphases mine)

Lehman (1986, pp. 108-109) proposed:

> Deposits of Cenomanian through Campanian age (Cretaceous) record the gradual filling of the Chihuahua Trough and inundation of the Coahuila Platform with terrigenous sediment derived through erosion of subduction-related volcanic rocks in Sonora. In Maastrichtian (Upper Cretaceous) time, deformation in the Chihuahua Tectonic Belt to the west, and in the Del Norte-Santiago-Del Carmen Uplift to the east, restricted sedimentation to the intervening region -the Tornillo Basin. **Sediment was derived through erosion of surrounding Upper Cretaceous and Lower Cretaceous sedimentary rocks, and perhaps from nearby volcanic rocks in New Mexico and Arizona.** (parenthesis and emphasis mine)

Currently, uniformitarian scientists accept the transport of sediments and fossils from adjacent portions of the North American continent into the Big Bend region.

A Subaqueous Volcanic Source Alternative

It is proposed that the Pen Fm represents some of the first volcanic deposits generated subaqueously from calderas erupting, within the Trans-Pecos region (see Froede 1995b, 1996). However, the Pen Fm is viewed as "Cretaceous" by the fossils contained within its sediments; hence, it does not correspond directly with any known volcanic sources. Presently, the volcanic sediments and strata observed across the Park date to the "early Tertiary" using radiometric methods (see Henry, Price, Parker, and Wolff, 1989; Price, Henry, Parker, and Barker, 1986). Thus it would appear that a volcanic origin for the Cretaceous Pen Fm would predate the currently recognized Tertiary volcanic sources and resulting

****An excellent Young-Earth creationist critical review of the concepts relating to the Milankovitch Cycle can be found in Oard, 1984.

sediments. The author's interpretation creates serious problems from the standpoint of maintaining the uniformitarian stratigraphic timescale - or does it?

According to Maxwell et al., (1967, p. 300) the first volcanic activity recorded in the strata around Big Bend: ". . occurred in the Boquillas Formation where in some places thin, ashy clay layers are interbedded with the flagstone. Bentonitic clay layers are present in the Pen Formation . . ."

The bentonitic clay layers present in the Pen Formation represent the remains of a volcanic ash (see Williams and Howe, 1993) which was erupted in a marine environment and subsequently altered (for more information about bentonite clay being derived from volcanic ash see: Carozzi, 1993, pp. 93-95; Charnley, 1989, pp. 411-414; Fisher and Schmincke, 1984, pp. 336-340; Grim, 1968, pp. 566-570; Williams, Turner, and Gilbert, 1982, pp. 272-274).

Thus we have evidence to suggest that volcanic input was supplied to the area during the "Late Cretaceous." The next issue to be resolved is the source area for those volcanic layers. Were the original ash falls from distant volcanic eruptions (presently unidentified) or were they possibly locally derived? Again we turn to Maxwell et al., (1967, p.300), where they state:

> Tabular igneous bodies intruded the Pen and Aguja Formations on the west side of Mariscal Mountain and the Aguja Formation at the Cow Heaven anticline and Tortuga Mountain dome. These were probably emplaced during Late Cretaceous time and were folded concordantly in structures during the Laramide orogeny. Sills in the Boquillas crop out along the west side of the Sierra del Carmen and on Mesa de Anguila; they were probably also emplaced during Late Cretaceous time.

Price and Henry (1994, p. 221) documented the occurrence of igneous dikes (i.e., rhyolitic and basaltic) in and around the Big Bend National Park, some which are dated to the Late Cretaceous. Additionally, Lehman (1986) discussed the input of volcaniclastics into the Trans-Pecos region during the Late Cretaceous. Thus we now have evidences of igneous activity (locally derived) which could account for the volcanic sediments currently comprising the recognized "volcanic" layers of the Boquillas and Pen Formations. However, large-scale Late Cretaceous volcanic source areas have not yet been identified within the Big Bend/Trans-Pecos area. It is suggested that these Late Cretaceous volcanic sources are simply buried too deeply under their own volcanic sediments to be properly identified (see Froede, 1996). It is further proposed that subaqueously generated volcaniclastics (i.e., Pen Fm sediments) initially were deposited somewhat radially around the submerged erupting calderas from which they were derived. Regionally, these Pen Fm volcaniclastic deposits lie in the same direction as the much later Tertiary volcaniclastics (both groups of strata exist in a southeast to northwest trend).

Discussion

The Pen Fm contains invertebrate fossils which suggest a marine environment and would require a subaqueous setting. The fact that the Pen Fm is found, at some places, interbedded with the San Vincente Mbr suggests that the volcanic eruptions occurred while the epeiric seaway covered the region. The fossils serve to "date" the Pen Fm to the Late Cretaceous. Where the top of the San Vincente Mbr was possibly eroded (i.e., channels formed due to tidal action and/or water current scouring associated with the movement/draining of the Flood waters), the overlying Pen Fm would lie unconformably on top of the previously eroded San Vincente Mbr and would not "grade" into it. The author suggests that this is the case for the contact exhibited at the Lower Tornillo Creek Bridge (Figure 8). It is further believed that the fossils found in the Pen Fm were derived

Figure 8. Unconformable contact at this locale between the massive Pen Fm (left side-dark colored clays) and the adjacent/underlying San Vincente Mbr (right side-light colored rock). Note the layering of the San Vincente exposed along the road.

Figure 9. Tornillo Creek looking north. The San Vincente limestone outcrops at the base of the Pen Fm (light colored area). Again this contact is clearly not conformable and suggests the emplacement of the Pen Fm following the deposition of the San Vincente Mbr. Note gravel deposits and brecciated rocks (i.e., volcanic and non-volcanic) cover the top surface of the Pen Fm.

from the North American continent as the Floodwaters moved across it. Water movement was caused by both tectonic forces and withdrawal of the sea into the adjacent ocean basins. Sedimentary conditions associated with this time frame resulted in the erosion and transport of the various invertebrate fossils, from shallower marine environments on the North American interior, toward the south into the freshly erupted Pen Fm. Fossils were mixed within the Pen Fm as it was being deposited and reworked by these water currents (e.g., Barnette and Baumgardner, 1994). The rounded concretionary sedimentary features, found within the Pen Fm, provide further evidence of moving water. These rounded sedimentary objects were buried and compressed forming the disk-shaped features observed today.

While the Uniformitarians recognize much of the "Tertiary" volcanically derived sediments as possibly being deposited in an apron around the volcanic sources (see Stevens and Stevens, 1989a, p. 30; Stevens and Stevens, 1989b, p. 93; Walton 1986, pp. 251), no one has suggested that the Cretaceous Pen Fm represents volcanic sediments derived from nearby calderas erupting subaqueously. Again, this is because the "fossils" date the Pen Fm as being older than the currently recognized large-scale eruptions of volcanic rocks found in the Tertiary.

Applications Within The Young-Earth Flood Model

The author suggests that the uniformitarian Upper Cretaceous epeiric seaway reflects the transition from the Middle to Upper Flood Event Timeframe within the Young-Earth Flood Model (Figure 2) [Froede, 1995c]. The San Vincente Mbr of the Boquillas Fm represents the sedimentary conditions of the epeiric seaway created as the Flood waters covered the interior of the North American continent. The Pen Fm is suggested as reflecting some of the first deposits of subaqueously derived volcanic sediments which occurred within the region during the Upper Flood Event Timeframe-see Figure 2.

The Pen Fm reflects altered volcaniclastic sediments. Calcareous intervals in the lower sections of the Pen Fm probably reflect paleosurfaces where waters deposited calcareous sediments derived from the adjacent North American continent due to continental tectonic processes (e.g., the Laramide Orogeny). Along with the calcareous sedimentary input, invertebrate fossils were also supplied resulting in a variation in lithology and paleontology from the underlying San Vincente Mbr.

The fact that the Pen Fm is not consolidated reflects the distance from the heat source from which these deposits were derived. If sufficient heat were available during the initial deposition then these clastic sediments would have been "welded" volcanic units with calcareous layers and fossils found along the tops of each unit. The fact that fossils are found within the Pen Fm indicates that some mixing occurred as the volcaniclastics were deposited below their welding temperature. This reworking would have also served to rapidly alter and break down the volcaniclastic deposits into nondescript clay layers thus removing any obvious physical evidences (e.g., glass shards, welded fragments, etc.) of its volcanic origin.

Conclusions

Fossils within the San Vincente Mbr of the Boquillas Fm are found within alternating calcareous layers and represent possible "storm-event" deposits. This suggests a high-energy time frame which would correlate to the Middle Flood Event Division (Figure 2). The overlying dark clays of the Pen Fm contain a different (i.e., shallower marine) invertebrate faunal assemblage, probably derived from the epeiric seaway fauna on the adjacent North American continent. The Pen Formation deposits would represent the first deposits of the Upper Flood Event Division which mark a change in geologic-energy levels (Froede, 1995c; Reed, Froede, and Bennett, 1996).

The justification for this reasoning is based on the establishment of marine life (as evidenced by fossils) on the North American Continent during the Flood for an uncertain period of time. This environment existed long enough for some marine-life forms to flourish. At some point, while Floodwaters covered this portion of Texas, tectonic processes (still incompletely understood) resulted in the generation of volcanic eruptions in the Trans-Pecos region.

Currently, the uniformitarian model has not addressed the paleoenvironmental setting in which the Pen Fm was deposited (e.g., deep-water shales and the shallow-water fossils which they contain). Additionally, the origin of the Pen Fm remains unresolved. This catastrophic interpretation fits the rock record exposed within this area and supports the time frames suggested by the Young-Earth Flood Model (Froede, 1995c). This Young-Earth Flood Model interpretation supplies a reasonable and defendable position of the contact between the San Vincente Mbr of the Boquillas Fm and the overlying Pen Fm as found at the Lower Tornillo River Bridge.

Acknowledgements

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Quote - Fourteenth Century Europe's Worldview

From *A Distant Mirror* by Barbara W. Tuchman. 1978. Knopf. New York. A history of the fourteenth century in Europe.

Writing of the difficulties a historian experiences in attempting to chronicle a time so distant from our own, Ms. Tuchman states: (Foreword, page xix)

> Difficult of empathy, of genuinely entering into the mental and emotional values of the Middle Ages, is the final obstacle. The main barrier is, I believe, the Christian religion as it then was: the matrix and law of medieval life, omnipresent, indeed compulsory. Its insistent principle that the life of the spirit and of the afterworld was superior to the here and now, to material life on earth, is one that the modern world does not share, no matter how devout some present-day Christians may be. The rupture of this principle and its replacement by *belief in the worth of the individual and of an active life not necessarily focused on God* is, in fact, what created the modern world and ended the Middle Ages. (Emphasis added.)

The author possibly sees "the rupture of this principle" and the resulting ascendancy of humanism as a benefit. Christians will see the rupture as the *source* of modern societal ills, and of the decline of Western civilization.