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Late Pleistocene Stratigraphy of the Lower Nueces River, Corpus Christi, Texas: Glacio-eustatic Influences on Valley-fill Architecture

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ABSTRACT

This research describes a chrono-stratigraphic framework for alluvium within the lower Nueces River valley. The alluvial stratigraphy is then correlated to a eustatic curve, and the relationship between glacio-eustasy and valley-fill architecture is discussed.

Six informal allostratigraphic units were identified. Three older units incorporate the "Deweyville" terraces and the related alluvium (High, Middle, and Low Deweyville units). In addition there are at least two younger units. Deweyville units exhibit large amplitude and long wavelength meander scars (as compared to modern stream channel), and the underlying alluvium consists primarily of laterally accreted, coarse-grained sediments. The younger alluvium consists of vertically accreted, fine-grained sediments.

Thermoluminescence age-dates were obtained for the following strata: 1) Beaumont Fm- 91.7 ± 7.9 and 71.9 ± 6.1 ky (isotope Stages 5a and 5b); 2) High Deweyville unit- 52.6 ± 5.3 ky; 3) Middle Deweyville unit- 40.3 ± 3.2 and 41.3 ± 4.1 ky; and 4) Low Deweyville unit- 35.6 ± 2.1 and 31.4 ± 2.2 ky. Deposition of the Deweyville units occurred during isotope Stage 3. The younger alluvial units are pending age-dating, but are presumed Holocene in age based on examination of soil profiles.

Terrace gradient profiles trace to positions below modern sea level, at roughly - 30 m. Eustatic curves indicate that deposition of Deweyville units occurred when sea-level was 35 and 60 m lower than present, suggesting the lowered base level influenced the valley-fill architecture by controlling the paleofloodplain gradients. All three "Deweyville" units formed during a longer-term, complex glacio-eustatic fall, contrary to models that envision valley incision and sediment bypass during a eustatic fall and valley filling during eustatic rises and stillstands.

The differences in sediment grain-size, stratigraphic architecture, and the morphology exposed on the surface of the allostratigraphic units, when coupled with the timing of deposition suggest other factors may have influenced the stratigraphy as well.

INTRODUCTION

The manner by which coastal plain valleys are cut and subsequently fill is dependent in part on the slope of the continental shelf, antecedent conditions, changes in base level, as well as several other factors (Fisk, 1944; Blum, 1994; Wood et al., 1994; Anderson et al., 1992). The many variables complicating deposition in incised valleys demonstrates the need for more detailed models to adequately address cause and effect relationships in the stratigraphic record.

This research is part of a larger study on the evolution of the Texas Gulf Coastal Plain. It presents a description of the stratigraphy and a series of thermoluminescence (TL) age-dates for informally defined "Deweyville" allostratigraphic units in the Nueces Valley. Using the TL age-dates, the stratigraphic architecture of Deweyville units is correlated to one of the major influencing factors, glacio-eustasy.

METHODS

The valley fill was mapped using USGS 7 1/2 minute topographic quadrangles, 1:100,000 topographic / bathymetric maps, NHAAP 1:40,000 color infrared photographs, satellite imagery, previously published maps of the valley (Price, 1933; 1958; Aronow, 1971; Brown et al., 1976; Baskin and Cornish, 1989), and numerous field investigations by the author. Terrace gradient profiles were plotted by transposing the elevation of the terraces (determined from 7 1/2 minute quadrangles) to the valley axis for measurement of distance. Cross-sections were constructed from USGS topographic maps.

Soils were identified using methods described in Birkeland (1984). Informal allostratigraphic units were described using concepts developed by others along the Coastal Plain (e.g., Autin, 1992; Blum, 1994), and guidelines established by the North American Stratigraphic Code (1983). Quarry exposures, stream cutbanks, and cores allowed observation and documentation of stratigraphic relationships and unconformities in the Nueces River valley (Shideler, 1986; Cornish and Baskin, 1995; Durbin, 1996).

Very few radiocarbon age-dates exist for the valley alluvium (Baskin and Cornish, 1989; Conkin et al., 1962) for two reasons: 1) Exposures of the two older alluvial units (those underlying the two higher terraces) are rare; and 2) A paucity of fine-grained, organic-rich sediment exists in the exposures of the Low Deweyville unit. However, Deweyville units are dominated by sandy facies, making thermoluminescence (TL) age-dating an ideal method for an otherwise problematic setting.

A thorough explanation of thermoluminescence (TL) age-dating is described by Aitken (1985) and Berger (1988). TL dating relies on the premise that electrons, produced by radiation ionizing local atoms, become trapped by imperfections in any non-metallic crystalline lattice (Aitken, 1985). Electrons accumulate with time (until all traps are filled), and are released (measured as luminescence) as the crystalline lattice is vibrated (such as from solar heating). Two assumptions are needed to produce valid TL age-dates. First, the electron traps must have been emptied (i.e., zeroed) during transport of the sediments, leaving behind no residual electrons that would make the sample appear too old. Second, the rate of electron production (the dose rate) was constant and can be simulated and/or measured. Thermoluminescence age-dating is applicable to many environments (Forman and Machette, 1991), and has proven reliable for dating alluvium (e.g., Nanson and Young, 1987; Sherwood et al., 1994).

Sample collection locations represent each Deweyville allostratigraphic unit. Dateable sediments (well sorted, medium quartz sand) were collected by excavating down to unaltered material below the base of any soil profile developed on the terrace surfaces. Once the exposure was cleared and the sediments described, a clean PVC tube (diameter: 2 in; length: 10 in; thickness: schedule 40) was capped on one end and driven into the face of the exposure. The tube was then removed and the sediment encased within. The entire tube was then covered with duct tape and stored in cool place until they were processed. Samples were transported to the TL dating lab via express package transport companies, with instructions prohibiting x-ray procedures on the samples.

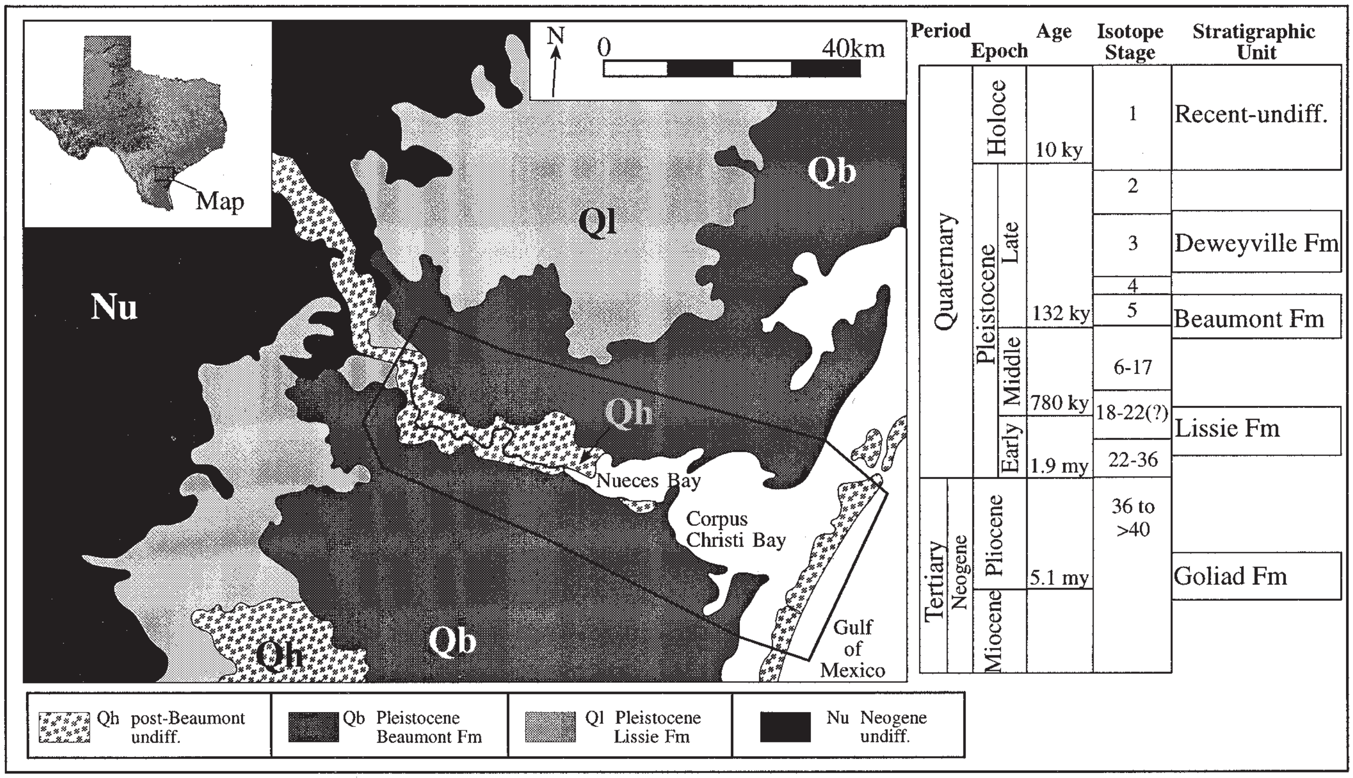

Figure 1. A Generalized Geologic map and stratigraphic column for the Texas Gulf Coastal Plain for the lower Nueces River drainage basin near Corpus Christi. Black outline denotes the coverage area of the detailed geomorphic map for the incised valley. Map modified from Barnes, 1975 and Brown et al., 1976. Stratigraphic column compiled from Barnes, 1975; Brown et al., 1976; Aronow, 1971; Shackleton and Opdyke, 1973; and Baskin and Cornish, 1989.

BACKGROUND

Geologic Setting

The study area lies within Jim Wells, San Patricio, Nueces, and Aransas Counties, near the city of Corpus Christi, Texas, and is located on the western part of the Gulf Coastal Plain physiographic province (Fenneman, 1938). This region of the Texas Coastal Plain consists of a large-scale coastal bight located between the Colorado/Brazos and Rio Grande alluvial-deltaic headlands.

The Nueces River is a bedload stream (Gustavson, 1978), and the trunk stream for a drainage basin that covers approximately 43,370 km2. Major tributaries in the Nueces system head in the Cretaceous carbonate uplands of the Edwards Plateau, then merge while flowing across the Western Gulf Coastal Plain. The Coastal Plain (Fig. 1) consists of a succession of Neogene through Quaternary alluvial-deltaic and coastal strata (Barnes, 1975; Brown et al., 1976; Galloway, 1989; Galloway et al., 1991; Coleman et al., 1991). The outermost suite of alluvial-deltaic deposits, the Beaumont Formation (Aronow, 1971; Brown et al., 1976; Winker, 1991), likely represent the "Sangamon" interglacial highstand (Stage 5).

Alluvial deposits within the Nueces valley are inset within, and younger than Pleistocene Beaumont strata, and have long been presumed to record fluvial activity over the last glacial cycle. The Nueces-Corpus Christi Bay complex represents the valley of the Nueces River, cut as it extended across the shelf during the glacial period, and then flooded during the ensuing glacio-eustatic rise. Valley walls along Corpus Christi Bay have been modified significantly by waves during the present sea-level highstand, widening the valley and giving the bay an overall circular appearance (Morton and Paine, 1984). The modern barrier islands presumably formed during the latest stages of marine transgression and present sea-level highstand (Shideler, 1986; Morton and Price, 1987; DuBar et al., 1991).

Development of the Deweyville Allostratigraphic Unit

Early researchers (e.g., Deussen, 1924; Barton, 1930a; 1930b; Price, 1933; 1958; Weeks, 1945; Bernard, 1950; Doering, 1956) recognized the presence of terraces within the valleys of major streams along the Texas Coast. Bernard (1950) first used the term "Deweyville" to describe terraces in the Sabine River valley near Deweyville, Texas, which occurred below the level of the Beaumont surface, but above the modern floodplain surface. Along with stratigraphic position and elevation, "Deweyville" terraces are notable because of ubiquitous relict meanders that are of larger amplitude and longer wavelength than those of either the Beaumont or modern floodplain surfaces. Bernard (1950) related "Deweyville" terrace formation to Fisk's (1944) model of episodic, glacio-eustatic driven base-level changes.

Since Bernard's initial description, many researchers in east Texas, Arkansas, and Louisiana have identified surfaces interpreted as "Deweyville" terraces on the subaerial Coastal Plain (Gagliano and Thom, 1967; Bernard and LeBlanc, 1965; Aronow, 1968; Saucier and Fleetwood, 1970; Alford and Holmes, 1985). In addition, fluvial deposits within incised valleys on the now-transgressed portion of the shelf have been interpreted as former "Deweyville" terraces (Anderson et al., 1992; Thomas and Anderson, 1994). A number radiocarbon ages span the period 13 - 35 ky (e.g., see Gagliano and Thom, 1967; Blum, 1994), but "Deweyville" ages inferred during other investigations vary from 9 ky (Alford and Holmes, 1985) to more than 100 ky (isotope Stage 5c; Thomas and

This Paper*	Price (1933; 1958)	Cornish and Baskin(1995)‡	Chronologic Age
Holocene-undiff.	Modern Floodplain	CA3	< 13.2 ky BP‡
Low Deweyville	Not named, but recognized as remnants	CA2, CA1, Angelita	31.4 ± 2.2 ky* 35.6 ± 2.1 ky*
Middle Deweyville	Angelita Terrace	Bluntzer, Fort Lipantitlan	40.3 ± 3.2 ky* 41.3 ± 4.1 ky*
High Deweyville	Corpus Christi Terrace	Corpus Christi Terrace	52.6 ± 5.3 ky*
Beaumont	Beaumont	Beaumont	71.9 ± 6.1 ky* 91.7 ± 7.9 ky*

Table 1. Correlation of previously published units with terminology used in this paper. Superscripts denote the source of the age-dates.

Anderson, 1994).

Research along east Texas rivers and in the Nueces valley therefore indicates multiple terraces may well fit the original “Deweyville Terrace” stratigraphic position, and there may be a range of ages associated with those terraces. Blum et al., (1995) addressed this issue by noting that most Texas Coastal Plain river valleys (including the Nueces River) contain multiple, mappable allostratigraphic units with stratigraphic and morphologic characteristics that conform to the “Deweyville” terrace as originally defined by Bernard (1950). They suggested use of the “Deweyville” allostratigraphic unit, and speculated that deposition may have spanned isotope Stages 4, 3, and 2, but provided no new dates. Morton et al., (1996) presented considerable data for post-Beaumont strata of the Sabine-Neches and Trinity Rivers, describing the allostratigraphic framework using Blum et al., (1995) Deweyville unit concept.

RESEARCH IN THE NUECES RIVER VALLEY

Previous Research

In the Nueces River Valley, Price (1933) named the highest surface the Corpus Christi Terrace and the lowest surface the Angelita Terrace (Table 1). Recent studies have built on previous work (Baskin and Cornish, 1989; and Cornish and Baskin, 1995) suggesting at least three terraces (including the lowermost “Deweyville” terrace) are older than the Cayamon Creek Alloformation (CA), reported as a terminal Pleistocene through Holocene age alluvial unit.

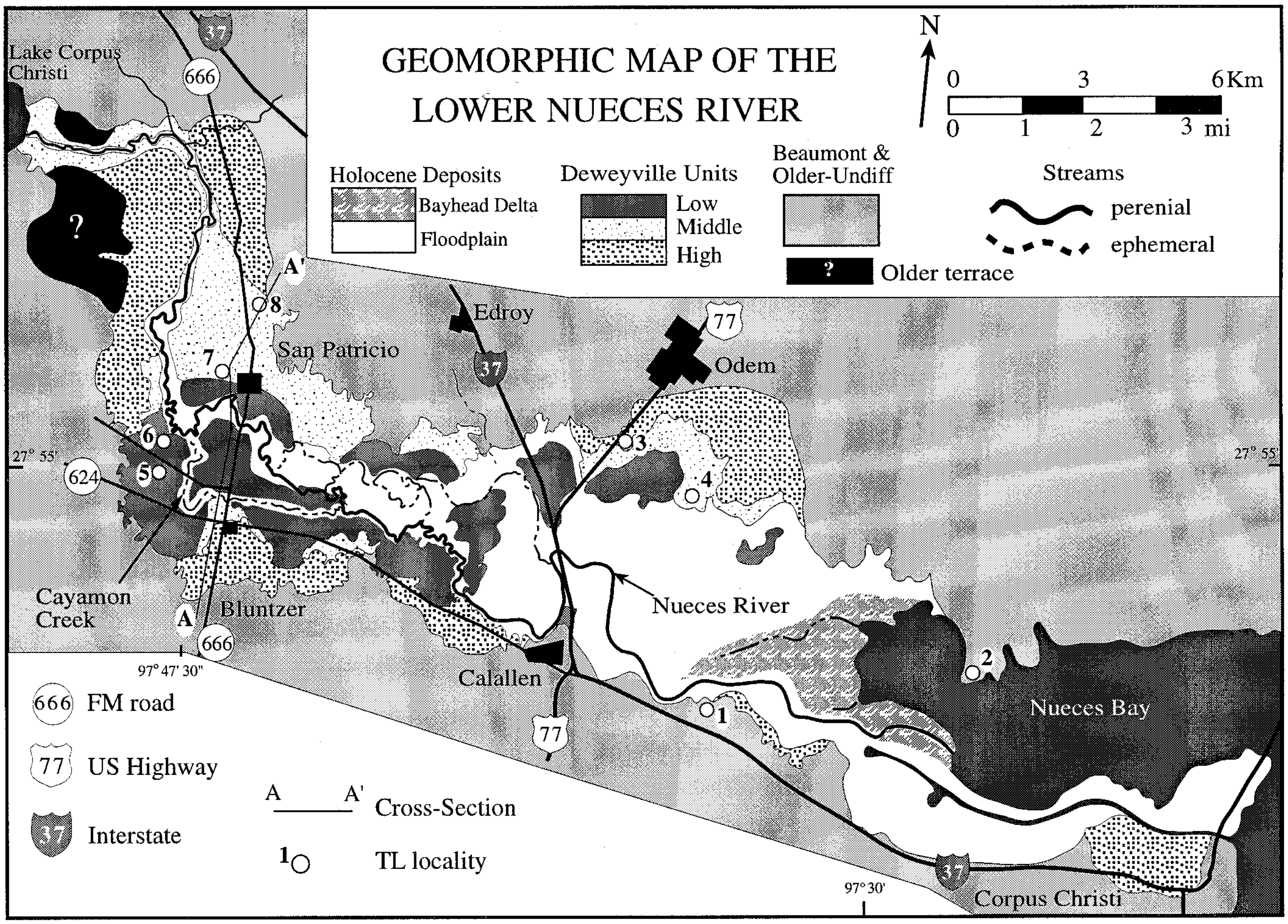

Figure 2. A geomorphic map of the Lower Nueces River valley from Lake Corpus Christi to Corpus Christi Bay. TL locations: 1 - Carbon Plant Road Sand Pit TL site; 2 - White’s Point TL site; 3 - Missouri-Pacific ditch TL site; 4 - Sorensen Ranch TL site; 5 - Wright Quarry TL site 1-13-94-1; 6 - Wright Quarry TL site 7-1-95-1; 7 - Fordyce Pit TL site; 8 - San Patricio TL site. Map compiled by field investigations conducted by the author, and adapted from United States Geological Survey 1:24,000 7.5 minute quadrangles. Other research that mapped the valley included: Price 1933, 1958; Aronow, 1971; Brown et al., 1976; Baskin and Cornish, 1989; Cornish and Baskin, 1995.

Cornish and Baskin (1995) envision the CA unit as a 15 m thick valley wide deposit, separating it from slightly elevated terrace remnants on the margins of the valley. The CA unit is subdivided into three members: 1) CA1, that has a basal Gravel facies (CA1a) and a muddy sand facies (CA1b); 2) CA2, a silty sand; and 3) CA3 a silty sand and the uppermost member . A radiocarbon age of 13.2 ky BP obtained from the CA1a dates the initiation of Cayamon Creek Alloformation deposition. Another radiocarbon date of 975 yr BP from a snail shell (Conkin et al., 1962) collected from a unit interpreted as CA2, was used to infer a separate interval of deposition for the CA2 member. The CA3 member relates to modern floodplain deposition.

Description and Age-Dates of Pleistocene Strata

Beaumont Formation

The sediments of the Beaumont Formation are extremely weathered, and distinguished easily from Deweyville units because of stratigraphic position, facies association, and soil development. Beaumont deposits consist of sandy clays and sands in multi-storied stacks of what are interpreted herein as flood basin mud and splay sands. Soil profiles exceed three meters, and where complete, typically exhibit thick black A-horizons, E-horizons, and thick, well-developed bright red-brown Bt and Bk horizons. Samples collected from Beaumont strata flanking the present-day Nueces Bay produced TL age-dates of 91.7 ± 7.9 ky (#1: see Fig. 2) and 71.9 ± 6.9 ky (#2: see Fig. 2), placing them within isotope Stages 5a and 5b, and bracketing the maximum age of the initiation of post-Beaumont valley fill (< 71 ky).

Deweyville Alloformations Terrace Elevations and Morphology

High (HD), Middle (MD), and Low (LD) Deweyville units often appear as terraces along the reach of the Nueces from Lake Corpus Christi to the modern bay mouth. In the lowermost reach of the study area near Corpus Christi, only the HD terrace is visible, occurring at elevations of 3 - 7 m (10 - 25 ft). Arcuate cuts in the valley walls adjacent to the bays indicate that younger terraces were present, but are now submerged (Price, 1933). In the middle reach of the study area near the town of Odem, the terraces occur at elevations of 15 - 18 m (50 - 60 ft) for the HD, 7 - 10 m (25 - 35 ft) for the MD, and at 0 - 4 m (0 -15 ft) for the LD. Terraces in the upper reach (near San Patricio) occur at elevations of 20 - 24 m (65 - 80 ft) for the HD, at 9 - 15 m (35 - 50 ft) for the MD and at 6 - 11 m (20 - 40 ft) for the LD.

All the terraces exhibit relict fluvial morphology, but most have been degraded by subsequent fluvial activity and slope processes. The Low Deweyville terrace has been modified extensively by fluvial activity, undergoing erosion in some locations and burial by younger alluvium in others. As such, the elevation of any terrace remnant may vary by one to three meters throughout the valley.

Planform geometry of paleochannels consists of large amplitude, long wavelength meander scars, clearly visible on topographic maps, aerial photographs, and satellite imagery. They contrast with the modern stream, which often reoccupies paleochannels and has many small, highly convoluted meanders.

High Deweyville Unit

No exposures of the HD unit were observed in the study area, and the nature of facies below the upper five meters is not well known. A partial exposure from a backhoe trench allowed description of the alluvium for the HD unit, just south of Odem Texas (#3; see Fig. 2). The upper 1.5 m consisted of silty fine sand at the surface, changing gradually to fine to medium, cross-bedded sand. A three meter thick soil was developed in the top of the HD unit, characterized by a thin A, an E-horizon, and a thick Bt-horizon with a carbonate-rich zone (Bk) below. A sample collected from a depth of 4.5 m produced a TL age-date of 52.6 ± 5.2 ky (#3; see Fig. 2), placing deposition of the HD unit during isotope Stage 3c.

Middle Deweyville Unit

Exposures in the MD unit are not readily available, and the depth to the lower unconformity is not known at this time. A partial exposure of the upper six meters in a gravel pit near San Patricio, Texas (#7; see Fig. 2) provides a good example of the MD unit. The lower four meters at this location exhibits planar and trough cross-bedded, medium and coarse sands that grade upward into planar and trough cross-bedded, medium to fine sands with pebbles. The upper two meters is a sand with 0.5 m thick lenticular gravel beds. A 2.5 m thick, well-developed soil exists at this location with a thin A-horizon, a 0.5 m thick E-horizon, a 1 m thick Bt-horizon and a carbonate-rich zone below. Carbonates are present below the Bt-horizon, appearing as root casts, carbonate-coated sand, or discrete spherical nodules. This facies is interpreted as point bar sands and gravel, based on the characteristics described above.

Backhoe trenches excavated at two additional locations in the valley allowed facies description and collection of samples for dating (#4, #8; see Fig. 2). Trench depths (3 m) extended below the base of pedogenic influence. The sediments consisted of fine to medium sand, with gently dipping planar and trough cross-beds at depth. Soil profiles were 2.5 m thick, consisting of a thin A-horizons, thick E and Bt-horizons, and carbonate rich zones underlying the Bt-horizons. TL age-dates from the MD unit were 40.3 ± 3.2 ky (# 4: see Fig. 2) and 41.3 ± 4.1 ky (#8: see Fig. 2), placing them

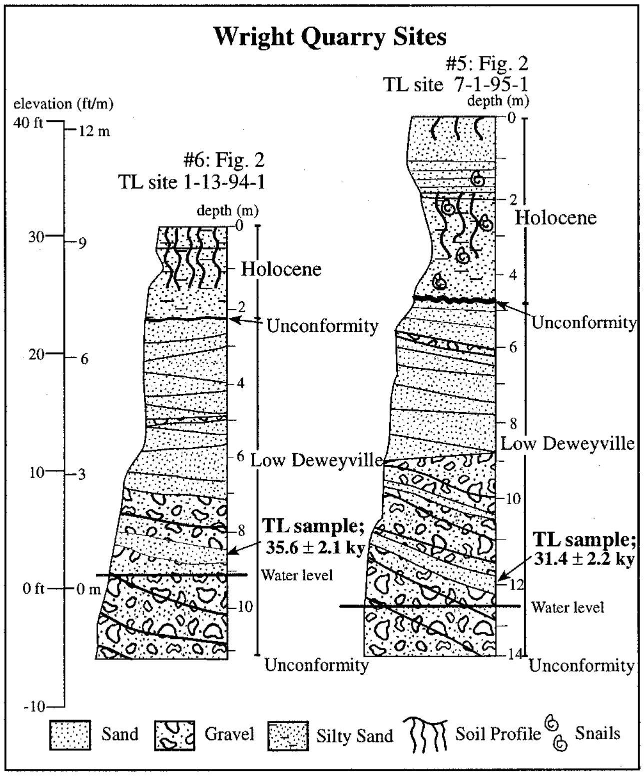

Figure 3. Measured sections from Wright's Gravel Quarries near Bluntzer, Texas demonstrating the facies associated with the Low Deweyville allomember and overlying younger sediments. Also shown are TL sample locations 1-13-94-1 (see Fig. 4) and 7-15-95-1 (#5, #6: see Fig. 2).

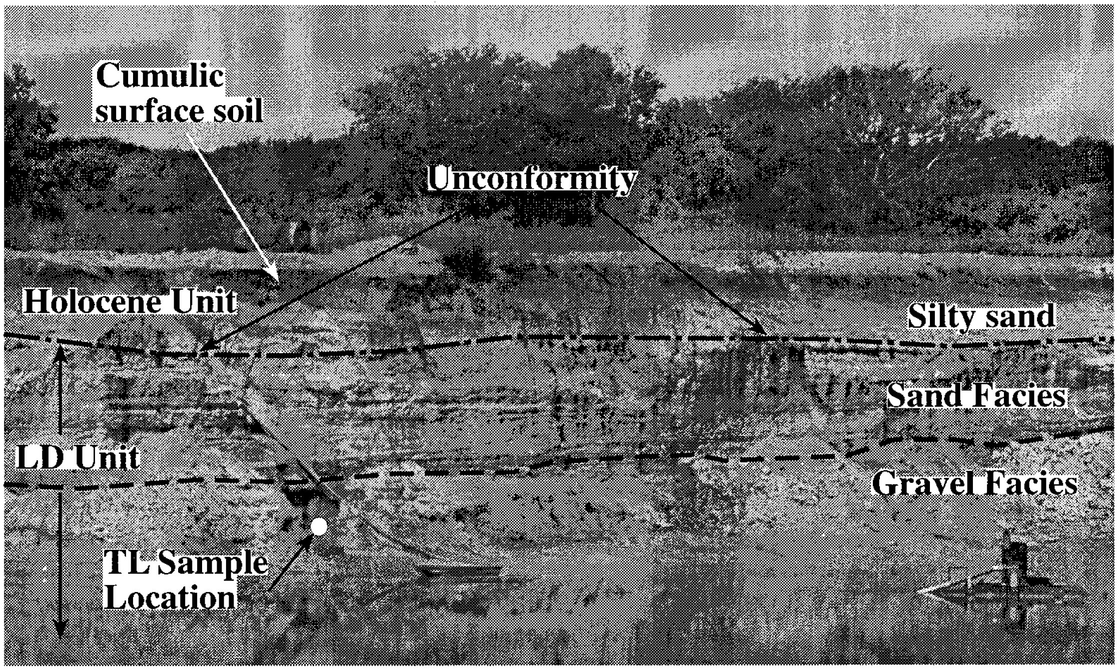

Figure 4. A Photograph of a Wright's Quarries (locality 5: see Fig. 2) gravel pit in the Low Deweyville (LD) allomember illustrating the facies relationships and the nature of the unconformity between the LD and Holocene units. The lower dashed line marks the boundary between facies in the LD unit. The dash-dot line represents an unconformity between the LD unit and overlying overbank fines and splay deposits from a Holocene unit. The white dot marks the location of TL sample 1-13-94-1. The boat at the base of the exposure is 3.6 m (12 ft) long.

within isotope Stage 3b.

Low Deweyville Unit

Two measured sections (Fig. 3) for the LD unit are shown from gravel pits that expose about 14 m of alluvium (e.g., see Fig. 4). The sediments in the lower four to five meters of this unit consist of planar cross-bedded gravel and coarse sand, fining upward to medium and fine sand with pebbles. The pebbles exhibit crude imbrication, indicative of current directions and energy. Only the upper three meters of the gravel bearing facies were exposed at the time of description, but conversations with quarry operators suggested that the base of the gravel was approximately 2 m (~ 6 to 8 ft) below the water surface. Overlying the gravels are 3.5 to 4 m of planar cross-bedded, coarse and medium sands with a few pebbles. A nearly horizontal unconformity truncates the upper part of this sandy facies, separating the LD unit from younger sediments. The younger sediments overlying the unconformity consist of horizontally bedded to gently dipping planar cross-bedded silty sand, with a moderately developed (A, Bw, C-horizons) 1.5 m thick soil profile. At many localities, modern sediments overlie this younger unit, with approximately one meter of fine sand and silt that are horizontally bedded. Soil profiles are weakly developed, with thin A and C-horizons and no Bt or Bw-horizons. The unconformity separating the LD unit from the overlying the sand unit merges with the surface near the valley margins, distal to modern channels. Soils developed in sedi-

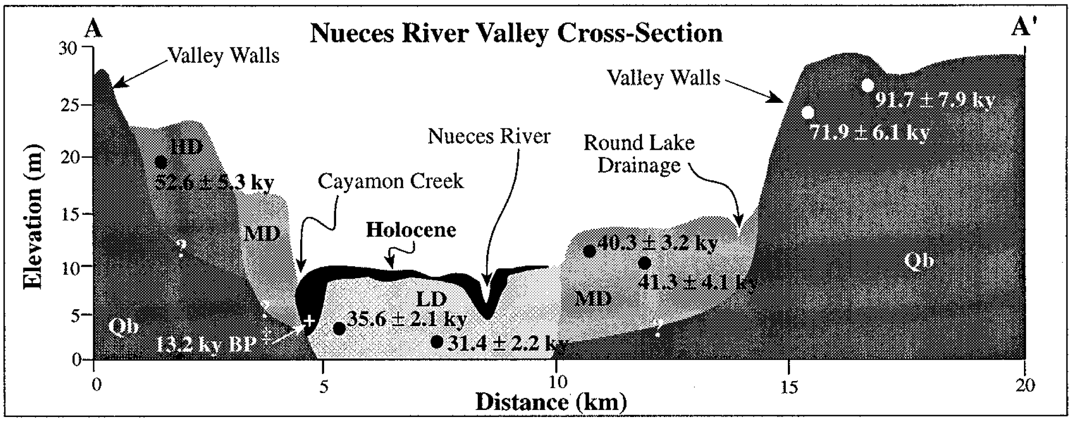

Figure 5. Valley cross-section A-A' (see Fig. 2 for location) illustrating the stratigraphic relationships between the Deweyville allomembers, and other strata. Qb: Beaumont Fm; HD: High Deweyville allomember; MD: Middle Deweyville allomember; LD: Low Deweyville allomember. Thermoluminescence (TL) age-dates for sites are shown in representative positions within the stratigraphic framework. Depth to lower unconformities of the MD and HD units along this section line is not known at the present time. The 13.2 ky BP radiocarbon age is from Cornish and Baskin, (1995) but placed within our stratigraphic interpretation.

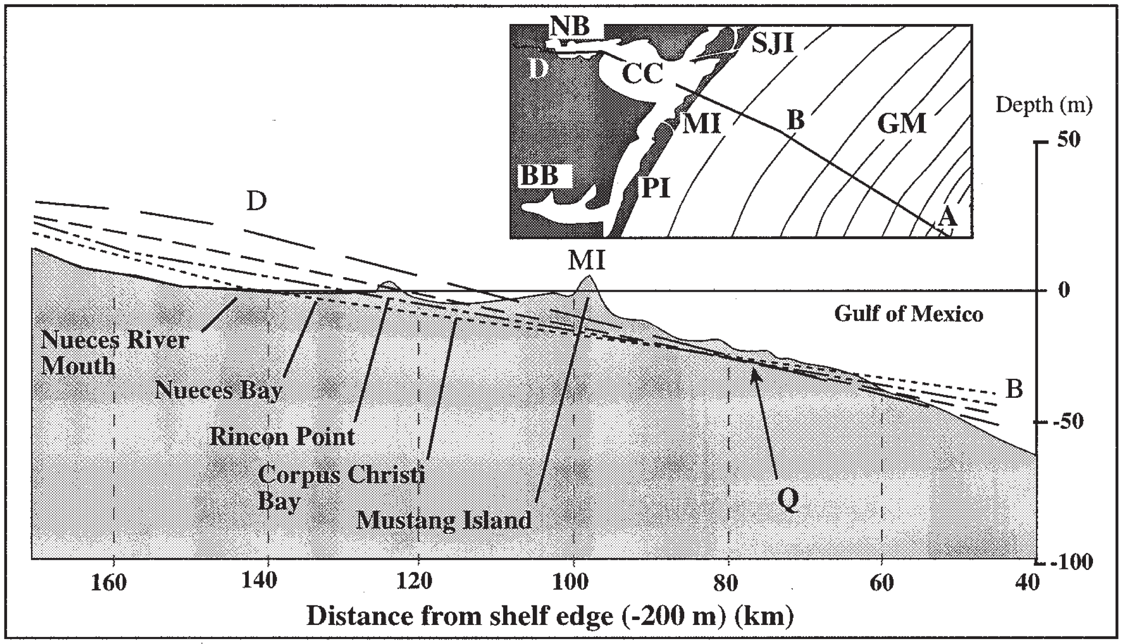

Figure 6. Terrace gradients superimposed on the modern continental shelf profile. The long dash line is the Beaumont surface. The medium dash line is the High Deweyville surface. The dash-dot-dot line is the Middle Deweyville surface. The short dash line is the Low Deweyville surface. Abbreviations (inset) are as follows: NB-Nueces Bay; CC- Corpus Christi Bay; BB- Baffin Bay; SJI- San Jose Island; MI- Mustang Island; PI- Padre Island; GM- Gulf of Mexico. Points A, B, and D are profile marks, and the bathymetric contour interval is 20 m. See text for reference to point Q. The profile shown begins at point B (see inset map). All surface elevations for terraces represent average values for each segment which were then displaced to the valley axis. The shelf profile was constructed using U.S. Geological Survey 1:100,000 bathymetric maps along the line shown.

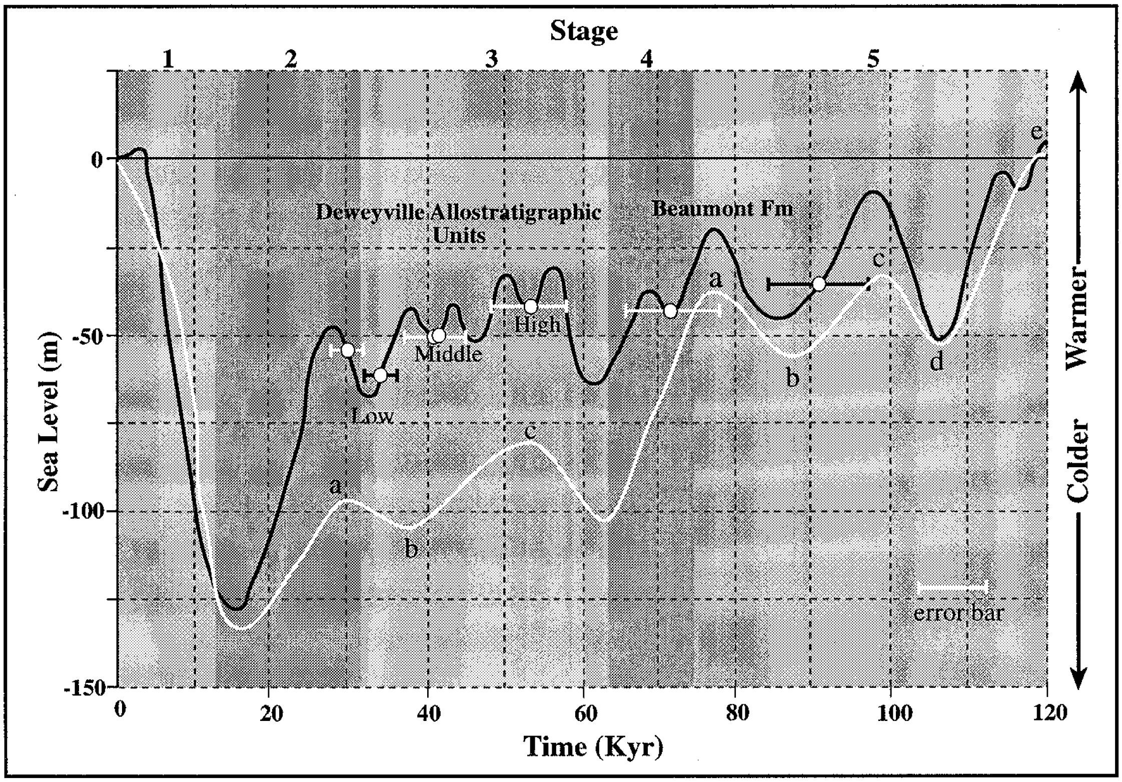

Figure 7. Thermoluminescence age-dates for Beaumont and Deweyville strata plotted on a eustatic curve (black; Chappell and Shackleton, 1986). Also plotted is a composite oxygen isotope curve derived from marine cores (white; Imbrie et al., 1984). See text for discussion of figure.

ments at locations where overlying younger sediments are thin (e.g., on the higher remnants of the LD unit) may exhibit a welded profile.

The lowermost facies of the LD unit is interpreted as channel and gravel bar deposits. The sandy facies, overlying the gravels and truncated by the overlying unconformity are interpreted as point bar deposits because of the cross-bedding, pebble stringers, and grain size. Sediments overlying the unconformity are interpreted as splay sands and overbank facies from a different stratigraphic unit.

Two samples were collected at a depth of 12 m at one location (#5: see Fig. 2) and 8 m from another (#6: see Fig. 2), that produced age-dates of 31.4 ± 2.2 ky and 35.6 ± 2.2 ky respectively (see Fig. 3 for measured sections). Thus, deposition of this unit occurred during isotope Stage 3a.

DISCUSSION

Comparison to Previous Research

The large meander cuts along the valley walls and terrace scarps, suggest that the same scale of fluvial activity produced meander cuts into the valley wall observed east of Bluntzer and near Calallen, Texas. The scale of the relict fluvial features just below the surface of younger floodplain sediments at this location suggest Deweyville scale channels as well. The present size of Cayamon Creek resembles that of the modern Nueces channel. By comparison, this suggests that channels with dimensions similar to the modern were too small to transport and deposit the volume of gravel and sand observed in the various quarries, and attributed to Cayamon Creek Alloformation deposition.

The welded soil profiles observed in pits near the margin of the channels suggest that this surface was the floodplain during the deposition of the underlying LD unit sand and gravel facies, and that soil development has kept pace with floodplain deposition on that surface. More importantly, the welded soil profiles developed at the surface of the LD unit is similar in development to those observed on the topographically higher portions of the allostratigraphic unit that appear as terraces.

The lack of an unconformity between the basal gravel and the sandy facies overlying it suggests that both are part of the former Low Deweyville floodplain, subsequently buried by vertically accreted floodplain deposits related to occupation of the present channel of Cayamon Creek and the nearby Nueces River. We interpret Cayamon Creek as an early Holocene or latest Pleistocene channel of the Nueces River, that took advantage of pre-existing low spots, and is inset within the LD unit. As such, Cayamon Creek reworked and eroded some of the underlying materials, formed terrace scarps in some locations, and deposited a thin mantle of material in the adjacent floodplain. The extent of the Cayamon Creek unit, by our interpretation, is therefore much more limited than in Cornish and Baskin's (1995) interpretation.

Several possible explanations exist for the discrepancy between the two studies: 1) The TL age-dates are inaccurate; 2) The radiocarbon dates are inaccurate; or 3) The age-dates from the two studies are derived from different stratigraphic units.

The similarity in age and agreement with our stratigraphic interpretations suggests the TL age-dates are valid. The radiocarbon date from the snails in the muddy sand (CA2- Cornish and Baskin, 1995) may be incorrect. The high sulfur content reported from the wood sample may indicate an environment capable of recirculating carbon (marshy floodplain), thereby contaminating the snails and affecting their apparent age. The same possibility exists for the wood sample that produced the 13 ky date. If all the age-dates are assumed valid, the third alternative seems most plausible. The area where the wood was collected is close to the modern Cayamon Creek (Baskin and Cornish, 1989, p. 27, Fig 2b). Using the stratigraphic interpretation presented herein (e.g., see Fig. 5), all the ages are assumed valid.

Correlation of Deweyville Units to Glacio-Eustatic Changes

The terraces represent former floodplain surfaces, and hence they should be graded to some profile at least partly controlled by sea level (base level). However, the effect of sea level on floodplain deposition varies with respect to factors such as the shelf slope gradients, sediment loads, and base-level changes. Terrace gradient profiles superimposed on a profile of the present transgressed continental shelf (Fig. 6) permit observation of several key points. First, "Deweyville" terrace gradients are steeper than the modern floodplain and exhibit roughly linear profiles where plotted. Second, the older Deweyville units possess steeper gradients than younger terraces. Third, linear projections of the terrace gradient profiles intersect at a single locality (point Q: Fig. 6), approximately 50 km offshore (70 km from the shelf edge, herein taken as the -200 m bathymetric contour) and roughly 30 m below the modern sea surface. Down slope from point Q, each younger Deweyville unit would bury previous units rather than incise into them.

A plot of the Deweyville units' ages on a graph of time versus sea-level elevations (Fig. 7) indicates that sea-level was 35 to 60 m below the modern elevation during terrace formation 52 to 30 ky ago. The correlation of Deweyville units to actual sea-level elevations is limited somewhat by the relatively large error terms associated with the age-dates. However, the ranges of sea-level elevation for each respective unit are as follows: HD unit: - 36 ± 4 m; MD unit: - 46 ± 4 m; LD unit: - 54 ± 7 m.

The rough correspondence between the terrace intersection point and the sea-level elevation during Deweyville deposition supports the idea of a lowered base level influencing terrace gradients. Several facts suggest the relationship between the stratigraphy and sea level is not a simple one. For example, if each successive sea-level fall was lower than the preceding (as most eustatic curves indicate for Stage 3), then each younger terrace profile should grade to a slightly lowered position on the shelf. This is not the case. The High Deweyville terrace gradient is the steepest (Fig. 6), suggesting a lower sea level than for the other terraces. However, the HD unit corresponds to the highest sea-level (Fig. 7). Perhaps short term variations in sea level occurred faster than floodplains could adjust their gradients. If true, terraces may well have graded to an average sea-level elevation, rather than to individual short term oscillations.

Another pair of observations may support this theory as well. The fact that the terrace profiles intersect at a single point supports the idea of average base level influencing the gradients. However, the elevation of the intersection point is too shallow for any average sea level calculated for the time of Deweyville deposition. This point (point Q: see Fig. 6) may represent the upslope limits of average base-level influence during deposition of the Deweyville units. As such, it would extend several meters higher than the actual elevation of sea level. Blum (1994) observed a similar stratigraphic architecture for the Colorado River, interpreting the upslope limit of base level influence (80 km upstream) as the location where Holocene strata progressively buried the Eagle Lake Alloformation (a Low Deweyville equivalent). In the Nueces River valley, the Holocene strata also bury the lowermost of the Deweyville units, with the upslope limits of onlap extending only 30 km upslope from the bayline. The transposition of the onlap point toward the Gulf is expected, considering the Nueces River has a steeper gradient and lower sediment load than the Colorado River. However, in both instances, the stratigraphic geometry appears related to coastal onlap initiated by a late Pleistocene through Holocene glacio-eustatic rise. The Deweyville units were deposited during a complex 30 m sea-level fall. However, the two ideas combined, average base level and the intersection point marking the upslope limit of average base-level influence, help to partially explain the observed relationships.

The aforementioned interpretation requires the following assumptions: 1) Sea level elevation and the overall shelf gradient are dictating the floodplain gradient, not the underlying materials; 2) Projections of terrace gradient profiles were roughly linear or convex, and changes in sea level occurred faster than the stream could achieve a graded (equilibrium) profile; 3) There has been no subsidence or depositional modification in shelf geometry since deposition of the Deweyville units; and 4) The age resolution is fine enough to prove useful for correlation of stratigraphic units to a general eustatic curve.

The river is incised into and is reworking poorly consolidated Beaumont formation sediments and older Deweyville units, thereby validating the first assumption. The second assumption appears valid as well. Research on drainage evolution in response to base-level changes shows that a base-level drop causes the downstream profiles of rivers to be thrown into a state of disequilibrium, indicated by a convex-up to linear longitudinal profile (Hack, 1965). Deposition of the Deweyville units occurred during a complex base-level fall, with numerous fluctuations, and thus may meet these criteria. Attempts to trace the terraces onto the transgressed part of the shelf require good control on the location of the post-Beaumont incised valley. This information is lacking for the Nueces River.

Suter and Berryhill (1985) interpreted seismic data from the Corpus Christi region as having a shore-parallel incised valley linking the now submerged ancestral Nueces River valley with the ancestral Rio Grande system to the South. The seismic lines (Berryhill, 1987) lie to the North and south of Corpus Christi Bays, trending perpendicular to the shore. A shore parallel line, needed to establish the presence of an incised valley on the shelf, is absent. However, if a shore parallel valley exists, it would act as a local base level, forcing streams to grade to it once sea level dropped below that point on the shelf. The terrace intersection point (Q: Fig. 6) coincides with the approximate location of the reported paleovalley on the shelf. However, recently collected data from offshore Corpus Christi Bay (Eckles et al., 1996) suggest that there may be no post-Beaumont incised valley on the submerged shelf.

Some seismic data within Corpus Christi Bay (Shideler, 1986) suggest fluvial sands are preserved in the estuary. However, the data lack the resolution and the positioning to define individual surfaces other than the top of the Beaumont, which marks the base of the valley at approximately - 30 m depth.

The third assumption is tenuous. Some research indicates that the region is relatively stable, and that there has been little uplift or subsidence related to eustasy or sediment loading (Morton and McGowen, 1980). However, no attempt was made to correct for changes in shelf configuration due to post-Deweyville marine deposition that has likely occurred (e.g., Eckles et al., 1996).

The TL dating lacks the resolution to correlate Deweyville units to small scale, high resolution eustatic fluctuations. It may be coincidental that three Deweyville units roughly correspond to three glacio-eustatic rise-and-fall episodes (Fig. 6). Regardless, the evidence presented suggests the age-dates are accurate enough to correlate the stratigraphy to low resolution, longer term sea-level elevations.

Other Factors Influencing Valley-Fill Architecture

Although a detailed explanation is beyond the scope of this paper, several lines of evidence suggest that base-level variations are not solely responsible for the architecture of the Nueces River valley fill. First, a dramatic change in channel dimensions and meanders scars is evident, when comparing the Deweyville units to younger alluvial units. Second, the Deweyville units exhibit facies and stratigraphic characteristics that suggest floodplain formation by lateral accretion, as opposed to the vertical accretion exhibited by the younger sediments. Third, the Deweyville units were deposited during isotope Stage 3, the climate of which is poorly understood at the present (Andersen and Borns, 1994; Frenzel et al., 1992), particularly along the Gulf Coastal Plain. However, the evidence derived from sources elsewhere in the world suggests that the Stage 3 climate was unique as compared to the modern interglacial or the last glacial maximum. As such, fluvial systems would have adjusted to those hydro-climatic conditions, and the valley stratigraphy would reflect those adjustments (e.g., see Blum et al., 1994). Lastly, the position of the interpreted upslope limit of average base-level influence accounts for relative position of terrace gradients on the shelf. However, upslope from that point, incision and subsequent terrace formation was likely initiated by climate driven discharge and sediment fluctuations independent of base level.

SUMMARY AND CONCLUSIONS

The lower Nueces valley has at least three terraces that are part of informal allostratigraphic units known as High (HD), Middle (MD) and Low (LD) Deweyville units. The youngest terrace has been reworked and partly buried such that resulting modern floodplain represents a composite of Holocene and Pleistocene fluvial activity. The terrace gradient profiles dip below modern sea level, with older terraces dipping more steeply than younger surfaces. The terraces possess relict morphology consisting of large amplitude and long wavelength meander scars and ridge and swale topography associated with floodplain construction. Sediments within Deweyville units are coarse grained, with general fining upward trends, and units typically exhibit large scale planar cross-bedding. Deweyville units lack fine-grained, horizontally bedded sediments associated with the younger sediments, suggesting older floodplains were constructed by lateral accretion rather than by vertical accretion.

A chrono-stratigraphic framework was established to allow correlation of alluvial units to independently derived records of sea level. Thermoluminescence age-dates from Beaumont valley walls and the Deweyville units suggest the Nueces River incised its valley into Beaumont sediments sometime after 70 ky. Deposition of Deweyville units occurred during isotope Stage 3 at ca. 52 ky, 40-41 ky, and 31- 35 ky for the High, Middle and Low Deweyville units, respectively. Correlation of Deweyville units to sea-level curves shows deposition occurred during a complex eustatic fall, with average elevations 35 - 60 m below the modern sea level elevation. Offshore projections of the terrace gradient profiles intersect at - 30 m on the shelf, generally corresponding to sea-level elevations at the time of deposition. However, evidence indicates the relationship between base level and valley fill is complex, and may involve other factors such as climate.

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Notes