EUSTATIC CONTROL ON ALLUVIAL SEQUENCE STRATIGRAPHY: A POSSIBLE EXAMPLE FROM THE CRETACEOUS–TERTIARY TRANSITION OF THE TORNILLO BASIN, BIG BEND NATIONAL PARK, WEST TEXAS, U.S.A.

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ABSTRACT: **Paleosol-bearing alluvial strata of latest Cretaceous and earliest Tertiary age are continuously exposed along Dawson Creek, in Big Bend National Park, west Texas, U.S.A., and exhibit a three-tier hierarchy of depositional cyclicity. Meter-scale, fluvial aggradational cycles (FACs) occur as fining-upward successions that are gradationally overlain by paleosols or are sharply overlain by the coarser-grained base of the succeeding FAC without an intervening paleosol. FACs stack into decameter-scale, fluvial aggradational cycle sets (FAC sets) that also fine upward, and from base to top contain either a gradual upsection increase in soil maturity and soil drainage or a somewhat symmetrical pattern of increasing and decreasing paleosol maturity. Longer-period trends of FAC thickness, lithologic proportions, paleosol maturity, and paleosol drainage indicate that two complete, and two partial, hectometer-scale fluvial sequences occur within the study interval. From base to top, each sequence is characterized by an asymmetric increase and decrease in FAC thickness, a decrease in the proportion of sand-prone fluvial facies, an increase in paleosol maturity, and better paleosol drainage.**

Whereas FACs and FAC sets are interpreted to record cyclic episodes of channel avulsion and stability, and longer-term avulsive channel drift within the alluvial valley, respectively, fluvial sequences may coincide with third-order sea-level changes within the North American Western Interior Seaway. As such, the Cretaceous–Tertiary (K–T) transition within the Tornillo Basin may provide an example of megascale stratigraphic cyclicity that is controlled by eustatic sea level within a fully fluvial succession. Thickening and thinning successions of FACs record a third-order period of accelerating (transgressive-equivalent) and decelerating (highstand-equivalent) base-level rise, and subsequent base-level fall (falling stage- to lowstand-equivalent). Sequence boundaries are placed at the sharp inflection between thinning and thickening FACs. Sand-prone facies and immature, more poorly-drained paleosols are associated with the transgressive-equivalent portion of each sequence, and mudrock-dominated overbank facies and their associated mature, well-drained paleosols are associated with the highstand- and falling stage-equivalent.

INTRODUCTION

Thick, relatively conformable alluvial successions and associated paleosols have been suggested to contain a hierarchical record of cyclic sediment accumulation produced in response to the combined effects of autogenic and allogenic processes (e.g., Beerbower 1964; Bridge and Leeder 1979; Bridge 1984; Kraus 1987, 1999; Kraus and Aslan 1999; Shanley and McCabe 1994; Kraus 2002). Kraus and Aslan (1999) describe this cyclic hierarchy as the product of micro-scale ($<$ 1 m thick, duration of days to months), meso-scale ($>$ 1 m thick, 1–10^2 yr duration), macro-scale ($>$ 10 m thick, 10^3–10^4 yr duration), and mega-scale ($>$ 100 m, 10^5–10^7 yr duration) aggradational alluvial episodes. Micro-scale and meso-scale sedimentary cycles are attributed to autogenic processes such as individual flood events and lateral channel accretion, whereas macro-scale cyclicity is attributed to a combination of autogenic and allogenic processes such as channel avulsion, regional climate change, and neotectonics (Kraus and Aslan 1999). Mega-scale alluvial cyclicity is often regarded as the product of allogenic processes such as tectonic activity and variable climate (e.g., Allen 1978; Read and Dean 1982; Blakey and Gubitosa 1984; Posamentier and Allen 1993; Legarreta and Uliana 1998; Kraus 2002). Although there is general agreement in the literature that eustatic sea-level change may also influence mega-scale alluvial cyclicity (e.g., Wright and Marriott 1993; Shanley and McCabe 1994; Schwans 1995; Quirk 1996; Kraus and Aslan 1999), uncertainties often associated with the correlation of alluvial cycles with coeval marine units, along with the potential for destructive (or constructive) overprinting by tectonic or climatic events of varying frequency and magnitude, make confirmation of a eustatic-sea-level mechanism difficult (Posamentier and Weimer 1993; Shanley and McCabe 1994; Ethridge et al. 1998). Because of these ambiguities, convincing examples of alluvial cyclicity produced in response to eustatic sea-level change are uncommon in the pre-Quaternary sedimentary record.

This paper unravels the hierarchy of cyclic processes that resulted in accumulation of the latest Cretaceous through earliest Tertiary Aguja, Javelina, and Black Peaks formations within the Tornillo Basin of Big Bend National Park, west Texas. The most recent studies of the Cretaceous–Tertiary (K/T) transition within the Tornillo Basin provide biostratigraphic and magnetostratigraphic age constraints (see summaries in Lehman 1990, p. 362–363, and Lehman 1991, p. 14), documentation of the relationship between episodes of Laramide tectonism and styles of alluvial sediment fill (Lehman 1991), and reconstructions of climate history from paleosol descriptions (Lehman 1989; 1990). This study evaluates the K–T alluvial succession in the relatively continuous exposures along Dawson Creek (Figs. 1, 2). Detailed sedimentologic descriptions of the Dawson Creek outcrop, including the abundant paleosols in the succession, are used to: (1) document the hierarchy of alluvial cyclicity (*sensu* Kraus 1987; Kraus and Aslan 1999); (2) differentiate between composite autogenic and allogenic cyclic mechanisms; and (3) compare against published conceptual and empirical models of fluvial sequence stratigraphy. In particular, we apply one-dimensional analysis of alluvial stacking patterns to evaluate whether eustatic sea-level change may account for mega-scale alluvial cyclicity.

Stratigraphic Overview and Paleogeography

The Tornillo Basin spans the border of west Texas and northern Mexico, and occurs along what was, during latest Cretaceous and earliest Tertiary time, the tectonically active southwestern margin of the North American Western Interior Seaway (WIS) (Lehman 1991). Although bounded on the west and east by the Chihuahua Tectonic Belt and the Marathon Uplift, the basin maintained a hydrologic connection with the WIS (Kauffman 1984; Lillegraven and Ostresh 1990; Lehman 1991). The Tornillo Basin is highly asymmetric, with the axis of subsidence and associated thickest sedimentary accumulations located in the southeastern part of the basin (Fig. 1; Lehman 1986). The Dawson Creek section is situated approximately 50 km west of the basin axis (Figs. 1, 2). Upper Cretaceous (upper Campanian to Maastrichtian) and lower Paleocene (Danian) sedimentary fill is entirely fluvial, and was deposited during an episode of tectonism within the Chihuahua Fold and Thrust Belt (Lehman 1991).

Outcrop exposures along Dawson Creek are dominated by overbank mudrocks (66% of decompacted thickness) that include abundant and well-developed paleosols (Figs. 3, 4). The Dawson Creek section has the best

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