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Channel-Fills: Not Your Average Point-Bar Deposit

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Summary

A comparative study using modern field methods (boxcoring and vibracoring, shallow reflection seismic, and point counting), in conjunction with outcrop logging (3-dimensional modeling, lab analysis, and strip logging) was conducted at Willapa Bay, Washington. Because of the depositional similarities between the ancient and modern (Clifton and Phillips, 1980; Gingras *et al*., 1999), relationships can be viewed between (a) depositional *versus* preserved morphologies; (b) the variation in the internal architecture of channel-fills as you move landward; and (c) the difference between channel-fills and point-bars. The Willapa Bay examples demonstrate that the outer and middle estuary is characterized by thick and wide point-bars, while the inner estuary is characterized by vertically accreted channel-fills, which are relative in size to the width and depth of the channel.

Introduction

Willapa Bay is situated along the northwestern coast of the State of Washington, USA (*figure 1*). The estuary is classified as an intermediate between a tide- and wave-dominated estuary (*Dalrymple et al., 1992*), and experiences mesotidal (2-4m) tides. Late Pliocene- to Pleistocene-aged outcrop terraces rim the bay to the north, east, and south, and occur locally inland. These terrace sets have been interpreted by authors (*Clifton and Phillips, 1982; Kvenvolden et al., 1979; Gingras et al., 1999*) to be reflective of similar depositional conditions to the modern bay.

Studies of both the modern and ancient have shown that within estuarine channels, the style, and thus the internal architecture, of tidal channel-fills is different from point bars. The inability of the channel to migrate prevents the establishment of a cut bank, encouraging the deposition of sediment across the breadth of the channel. As a result, vertical accretion dominates over lateral accretion. This can be seen in shallow reflective seismic lines taken across the Palix River, which persistently show continuous reflectors across the channel. This feature is also demonstrated in outcrop, where sand / mud couplets can be traced across the width of channels (e.g. *figure 2*). Intrastratal scours are commonly observed in both outcrop and from vibracores in the modern. These scours are typically demarcated by a 3cm to 5cm structureless mud atop them. The orientation and location of these scours, and the orientation of the sand / mud couplets above them suggests that they result from high energy freshettes, which act to move sediment in the seaward direction. This scouring results in the channel "shifting" its position, whereupon IHS is deposited atop the massive mud and scour surface (*figure 3*).

The sedimentological and ichnological components of these channel-fills is locationally dependent, and is controlled by (a) the relative amounts of sand and mud; (b) the relationship of marine (tides) and fresh (fluvial) inputs. At Willapa Bay, quartz sand is derived from tidal sources and the fluvial sources are mud prone mud (fluvial): this results in a sand rich outer-estuary, a mixed sand with rare mud middle-estuary and a mud-rich inner-estuary. The sediment distribution influences the distribution of the eta versus epsilon channel-fills. Moreover, trace-fossil morphology, diversity, and size reflect the salinity of the depositional waters. Thus, stratal architecture and ichnological data can be used to make highly refined predictions of the paleogeography of inner estuary deposits (*figure 4*). The outer estuary is subject to near fully marine conditions, and thus robust *Monocraterion, Ophiomorpha,* and *Thalassinoides* occur. As you move into the middle estuary and more persistent brackish-water conditions, an assemblage comprisiong *Teichichnus, Psilonichnus, Skolithos, Planolites, Arenicolites,* and *Siphonichnus* is observed. With salinity decreases into the inner estuary, ichnological diversity and size decreases: traces include *Planolites, Skolithos,* and *Gyrolithes*.

These observations have been observed in Cretaceous strata in Alberta, such from mine faces of the McMrray formation (*e.g. Muwais and Smith 1980*) and likely should be considered reasonable subsurface proxies for other mud- and tide-influenced units, such as parts of the Viking, Bluesky, Gething and Ostracod formations.

Conclusions

Channel-fills occur in a predictable fashion within an estuarine channel. Recognition of the relative amount of sand *versus* mud, and in the ichnological character can be used as a plaeogeographic indicator. Furthermore, the interpretation of a geoboby as representing an eta channel-fill may influence stratigraphic and reservoir modeling endeavors. The internal architecture and depositional character of channel-fills makes eta channel fills substantially different from point-bars. Because they are deposited across the width of the channel, they internally comprise both Inclined Heterolithic Strata <u>and</u> Horizontal Heterolthic Strata. This distinct style of deposition is why simply calling them a ‘point-bar’ can lead to inaccurate interpretations. The use of ‘Epsilon Cross-stratification’ and ‘Eta Cross-stratification’ when discussing channel-fills can help to mitigate such interpretational problems (*figure 5)*.

Figures

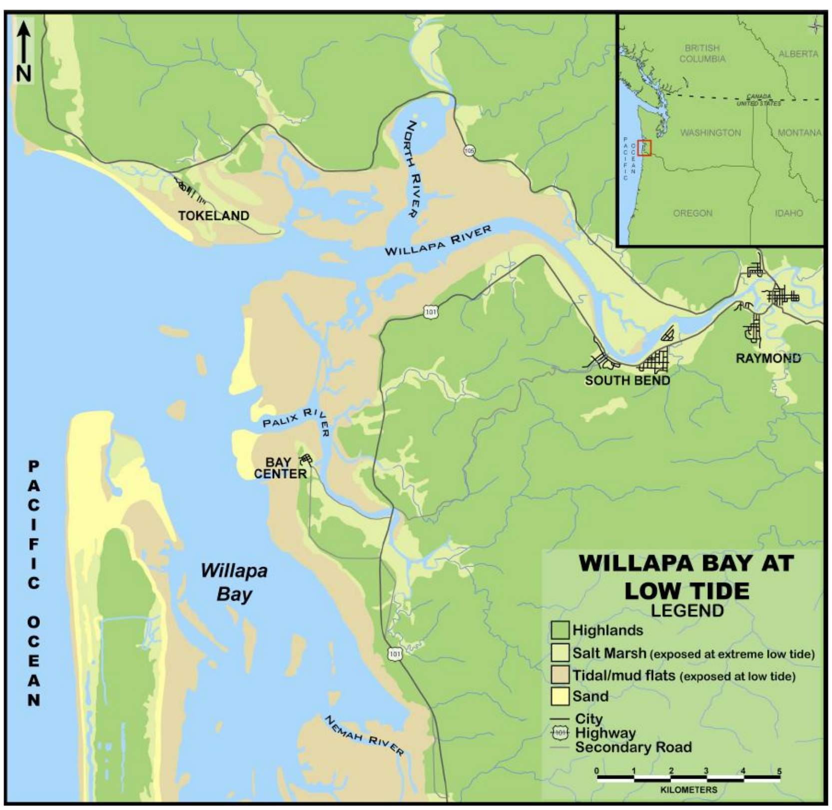

Figure 1: Location of Willapa Bay in SW Washington State, and blow-up of northern part of the bay.

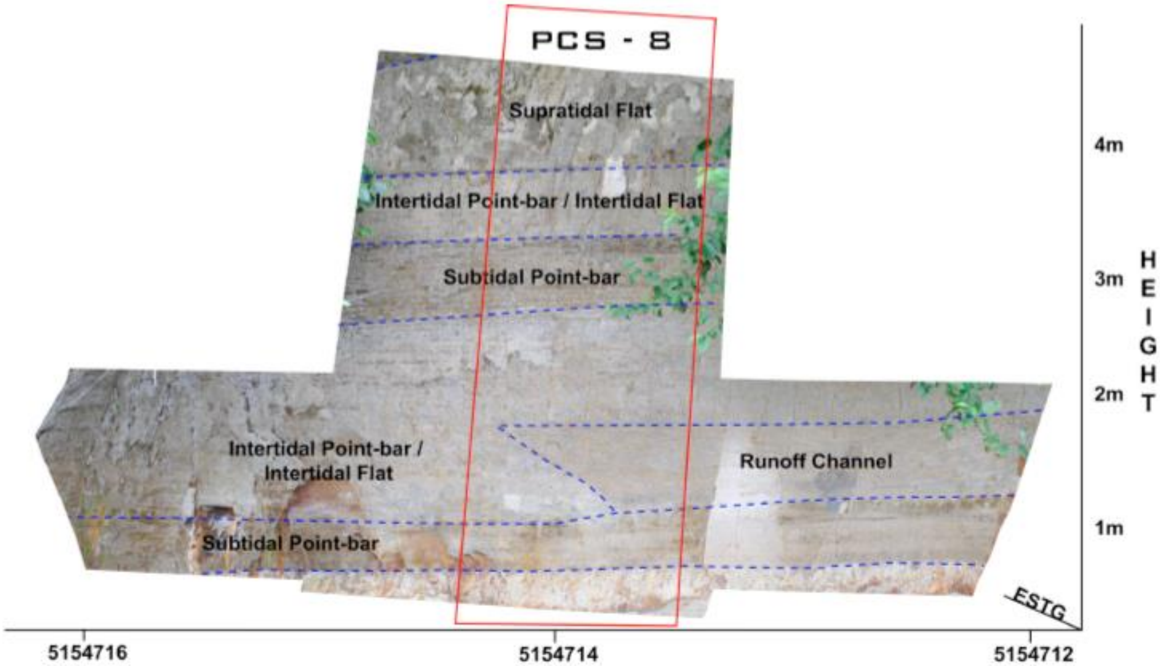

Figure 2: Outcrop example from Pickernell Creek South, showing intertidal and subtidal bar relationships.

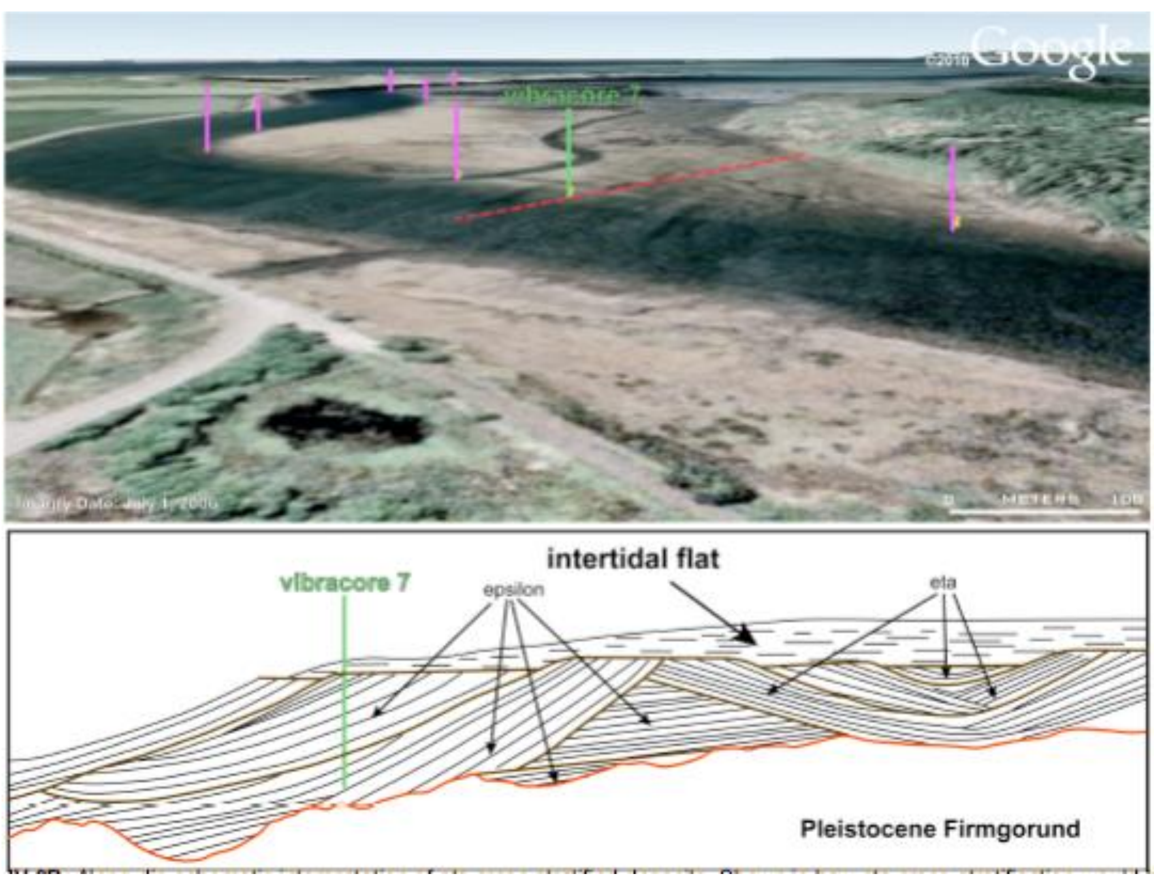

Figure 3: interpretation of channel-fill deposition from seismic and vibracores

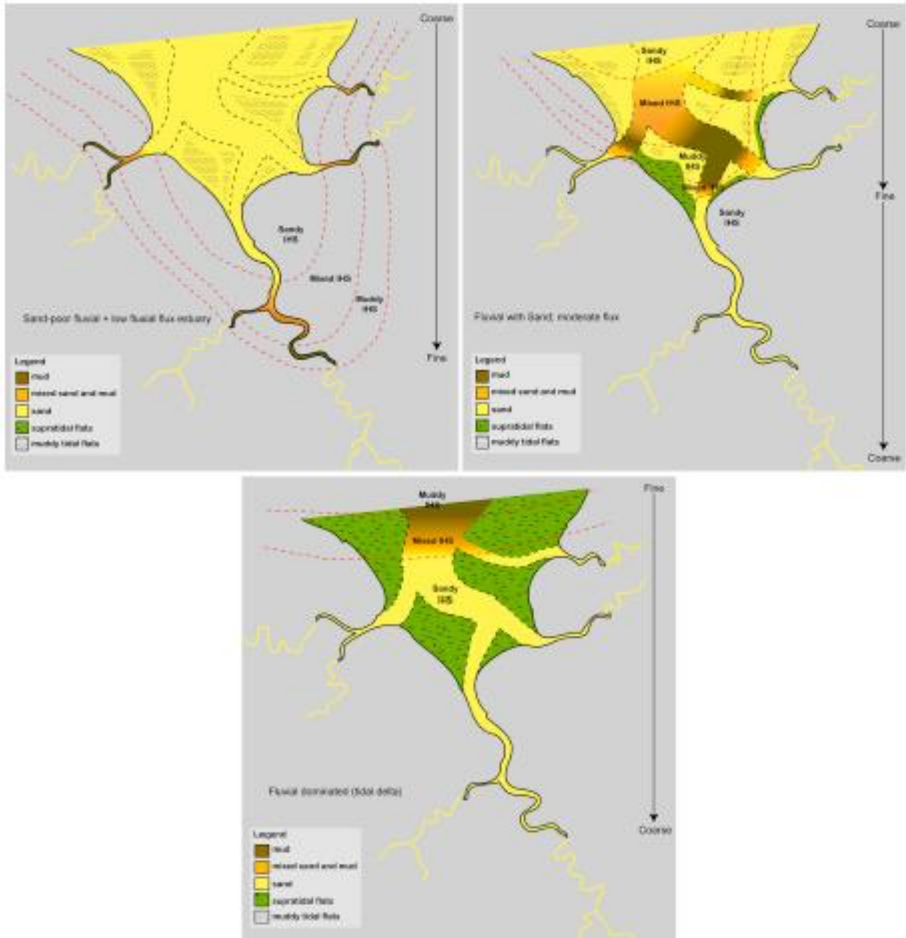

Figure 4: Use of sand / mud content and ichnological data to make paleogeographic interpretations

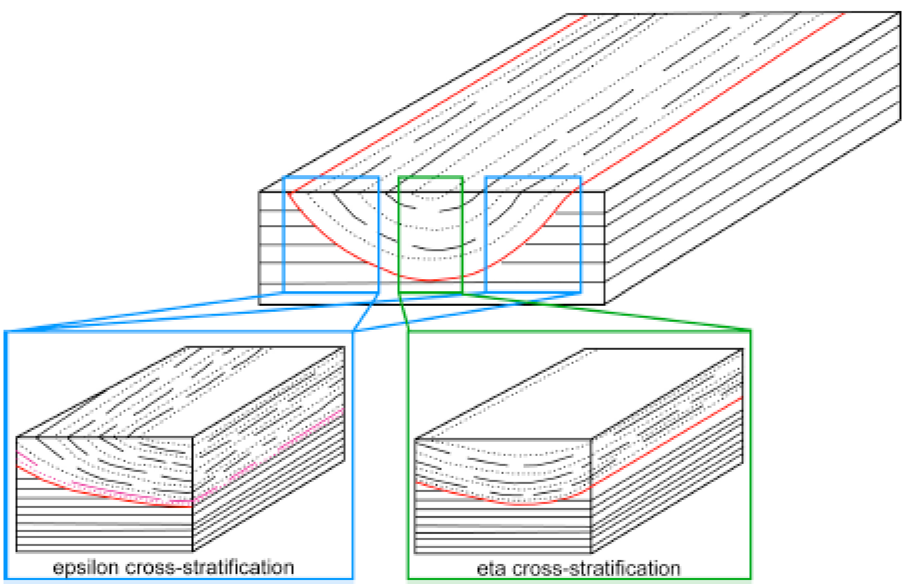

Figure 5: use / classification of ‘Eta-‘ and ‘Epsilon-Cross Stratification’

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