Preservational Complexity and Completeness in Channel Point Bars and the Heterogeneity of Heterogeneity in Their Reservoir Models*

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Abstract

Point bars tend to generate sandy lobate reservoir units that fill channels laterally and serve as primary development targets in both conventional and unconventional fluvial plays. Initial models for point bar growth build upon the presumption of periodic shingling of the convex inner channel bend with sheet-form sand layers that cover much of the wetted bend surface. Episodic and repetitive sheet addition causes the channel to migrate in expansional or translational vectors and produces sandy bodies partitioned with regularly spaced, gently dipping, bar-extensive, and sometimes draped accretion surfaces that record the channel form and resemble large cross sets. This results in reasonably predictable and easily modeled reservoir architectures. While field evidence argues that this fundamental modern process and rock product do occur in some approximation, an accumulation of additional field evidence argues that this process is not alone. At least three other processes also produce point-bar forms, and each of these processes preserves contrasting internal reservoir architecture. These processes are fragmentary bar accretion, counter point bar accretion, and mid-channel bar accretion. Fragmentary bar accretion results from high-frequency deposition of small unit bars over only limited areas of the wetted bar surface, commonly followed by dissection and erosional reshaping of the bar surface and local draping. This results in a bar deposit formed of highly fragmented reservoir units lacking through-going accretion sets and prone to unpredictable heterogeneity. Counter-point-bar accretion occurs by forced decoupling of the cut-bank flow shear and accretion along the cut-bank face. This produces concave accretion surfaces in strata typically much muddier and more heterogeneous than classic convexaccretion bars. Lastly, a lobe sandy body mimicking a true point bar may form in otherwise braided systems by preferential accretion of midchannel bars to the inside bend of a braided river that meanders. These tend to form sets of amalgamated sandy mid-channel bars into point-bar shapes that have mounded accretion surfaces at various orientations. These surfaces may move reservoir fluid flow in erratic direction. Each of these forms are common, and each includes long internal hiatal surfaces that result in total bar accretion rates that are much slower than rates of short-term bar growth.

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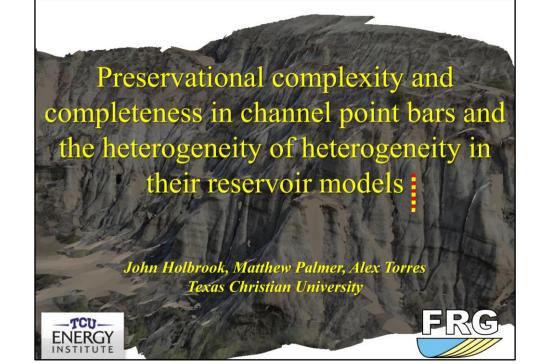
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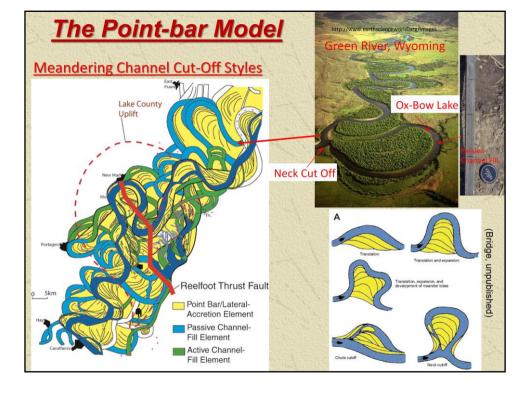
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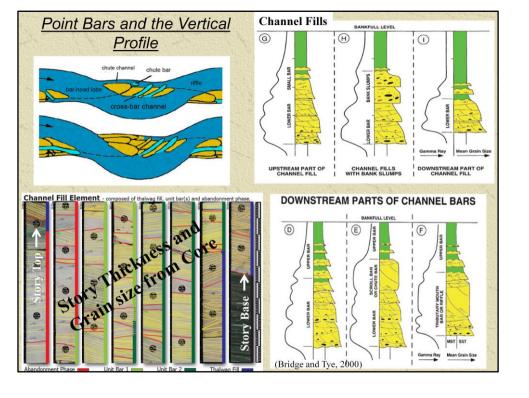
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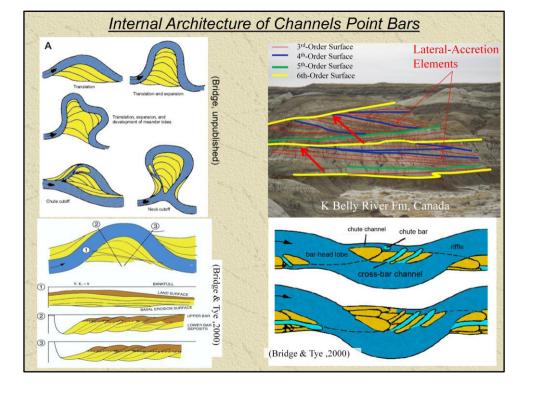
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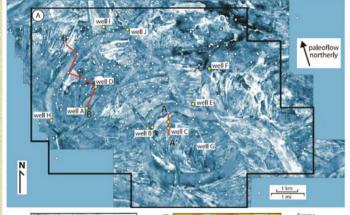


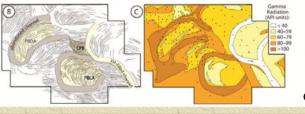






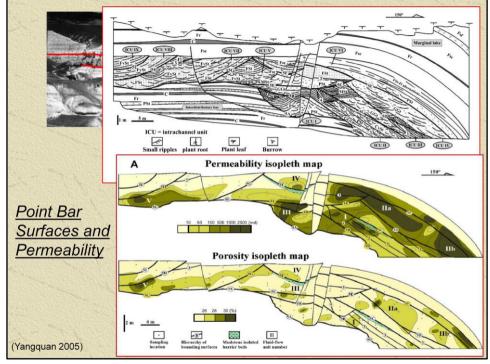
Imaging Bars and Channels in the K McMurray Fm, Alberta



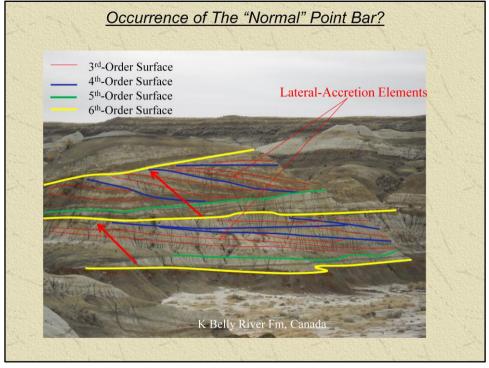


Recently Published image (Hubbard et al., 2011, AAPG Bull.)

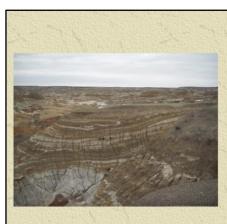
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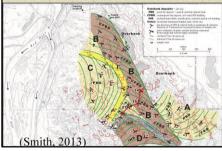
Presenter's notes: Permeability trends tend to follow bounding surfaces and the spatial lithofacies distribution that the bounding surfaces control. In the case of a sandy-gravely lacustrine delta-plain distributary channel deposit in the Karamay Fm, porosity and permeability are heterogeneously distributed. Fluid-flow units of high-porosity and high permeability zones tend to be close to and are controlled by 3rd or 5th order surfaces

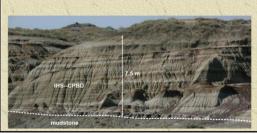


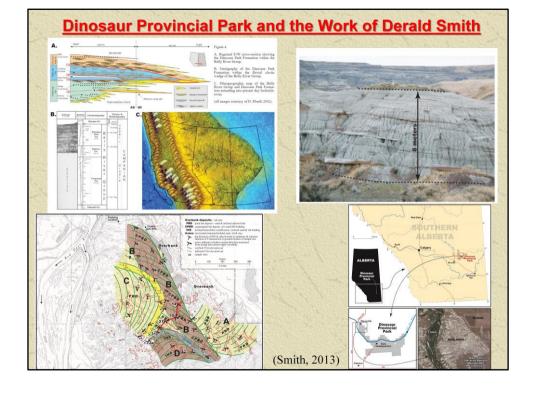
Presenter's notes: In this example, a lateral accretion element formed from a side-attached/point bar has marched across a thalweg fill of a channel above a lower lateral accretion element. The internal architecture of each element is complex recording higher-order accretion surfaces that reflect changes in bar migration direction.

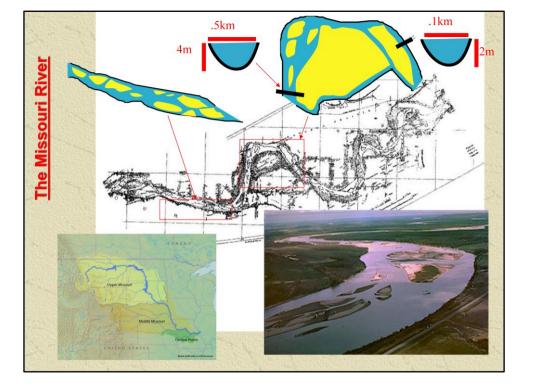


- 1) Counter Point Bar
- 2) Mid-Channel Bar Accretion
- 3) Fragmentary Point Bar
- 4) The Muddy Normal Point Bar





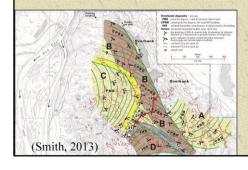




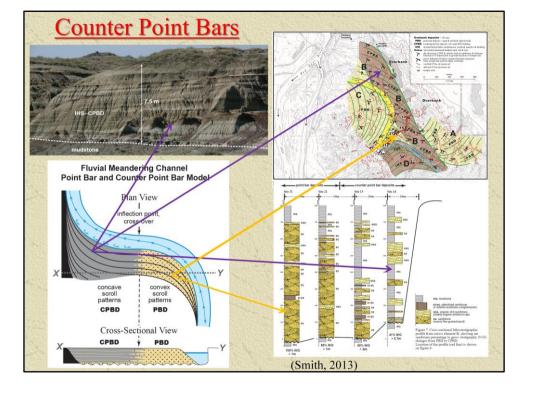


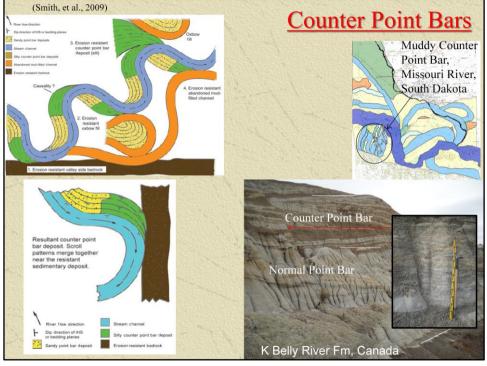
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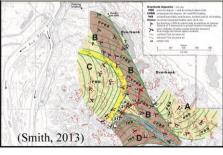


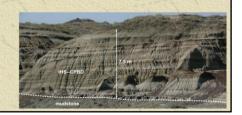


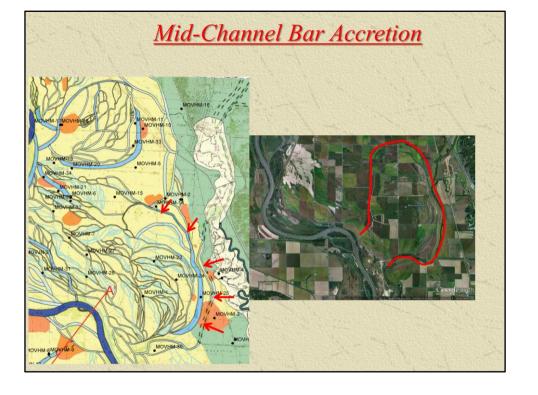
Presenter's notes: Counter point bars occur when bars migrate along the cutbank rather than the bar apex, either because of constriction of downstream bar translation. The slackwaters resulting tend to manifest as very fine-grained lateral accretion deposits.

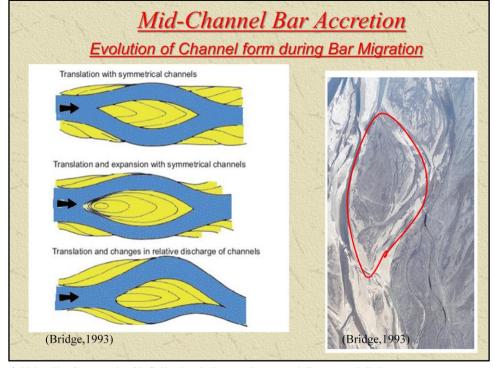


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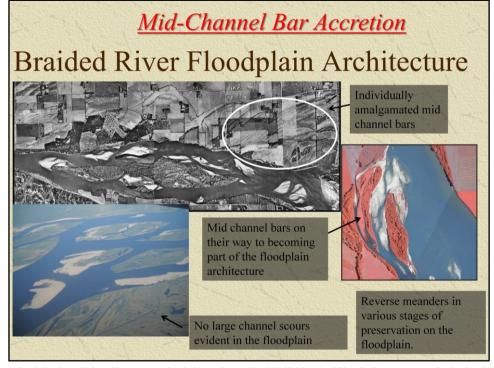








Presenter's notes: Migration of mid-channel bars forces contortion of the flanking channels. Bars may migrate symmetrically or asymmetrically downstream.



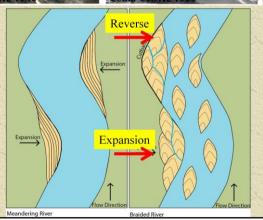
Presenter's notes: The real story here is that these mid channel bars are a second method to creating meanders in braided river. In addition, that they can move any direction they please.

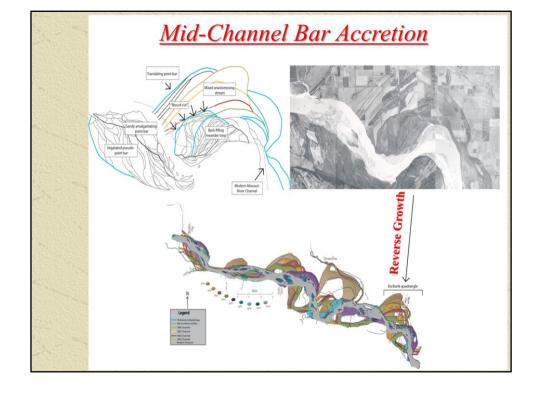


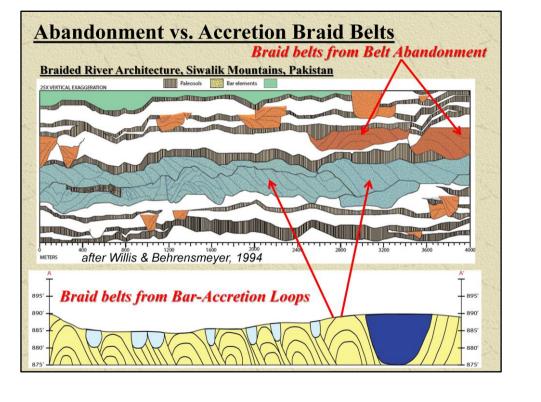


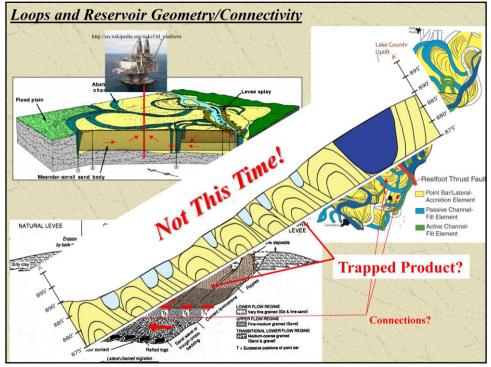


Mid-Channel Bar Accretion

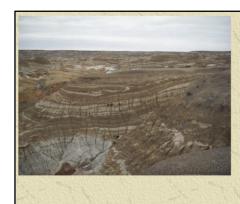






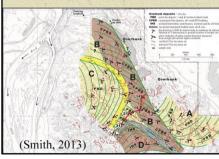


Presenter's notes: Even though flow can likely get under the channel to connect the bars, the upper channel is a barrier and prone to trap fluids. In addition, special consideration should be given to heterogeneity when draining a channel-belt reservoir. Drill penetration of a belt will only generally penetrate a single point bar, which will be compartmentalized by an engulfing channel fill. Production will drain the petroleum within the penetrated point bar readily, but production of petroleum from adjacent point bars requires connections. Passive channel fills will be highly effective barriers to flow and active fills will be moderately effective barriers. This means that connection between point bars will need to be made through the base of channel fills. Even if basal connection is effective, some substantial proportion of the petroleum can be trapped against channel fills in the tops of non-penetrated point bars. A production plan needs to compensate according to recover these fluids.



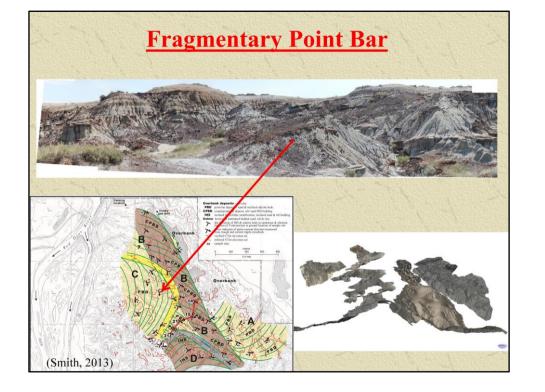
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- 2) Mid-Channel Bar Accretion

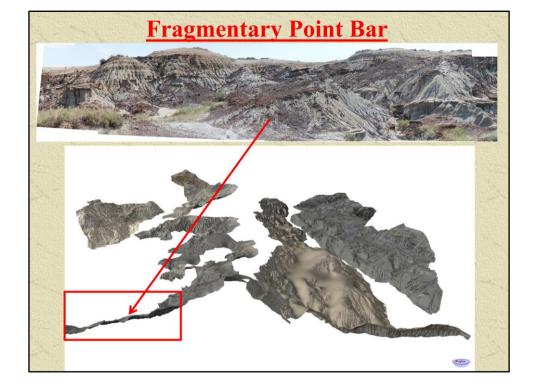
3)Fragmentary Point Bar

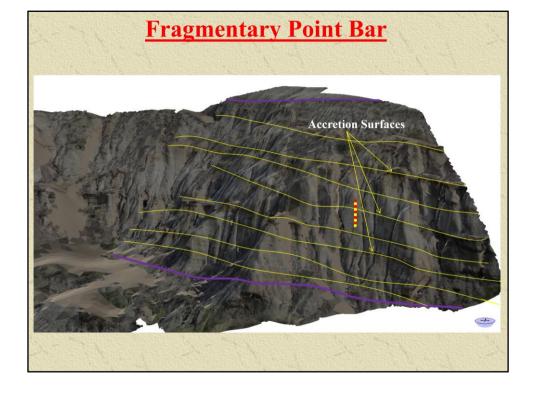


4) The Muddy Normal Point Bar

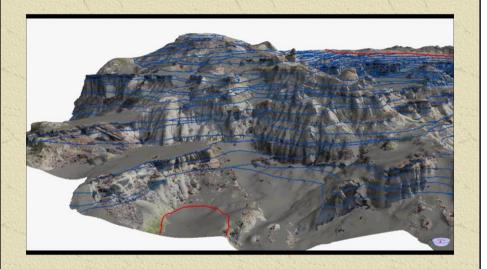


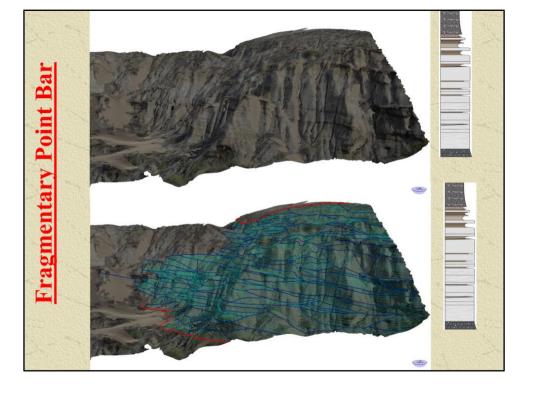


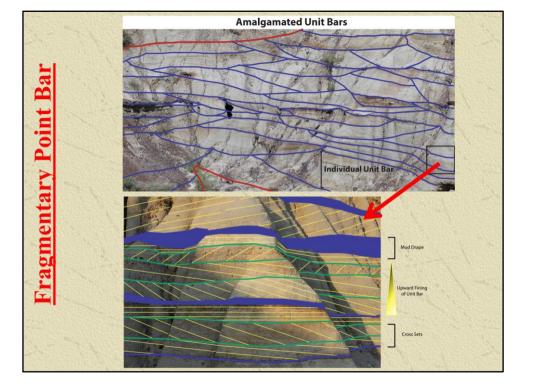


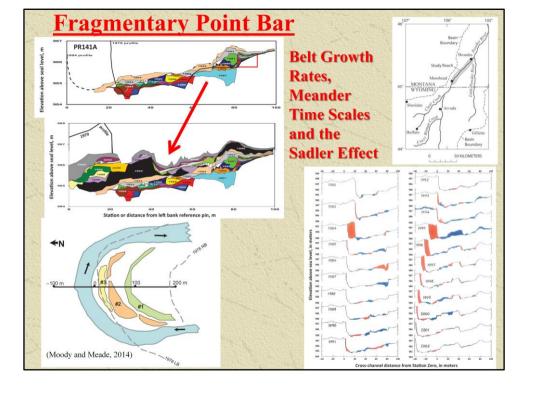


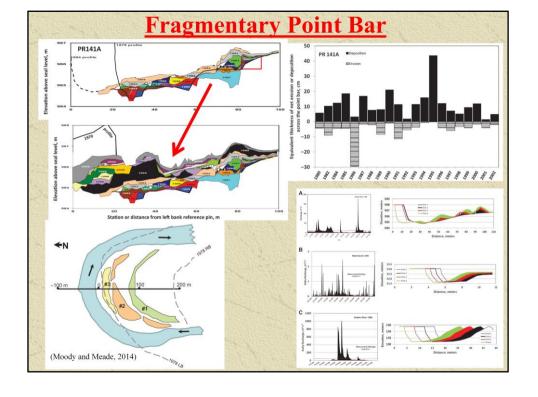
Fragmentary Point Bar







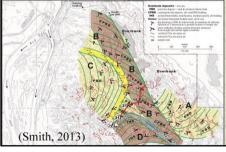


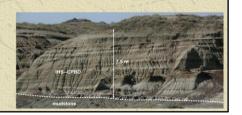


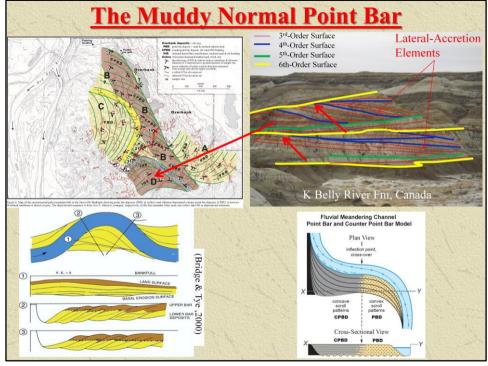


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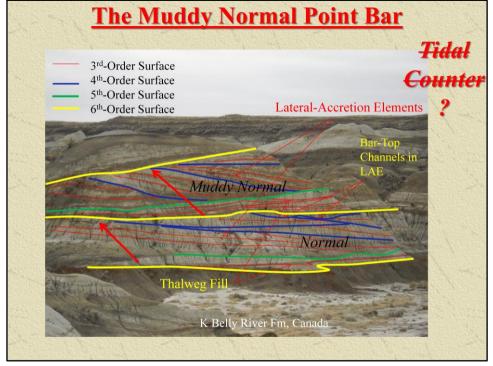
4)The Muddy Normal Point Bar







Presenter's notes: The primary autocyclic process at the bar/channel scale is bar migration. First, let us consider side-attached bars. Side-attached bars laterally migrate into the channel and thus form unidirectional lateral accretion surfaces between bar strata that may progress much farther than one channel width. During high flows, smaller channel may cross and dissect the bar top.



Presenter's notes: In this example, a lateral accretion element formed from a side-attached/point bar has marched across a thalweg fill of a channel above a lower lateral accretion element. The internal architecture of each element is complex recording higher-order accretion surfaces that reflect changes in bar migration direction.

