

An 18-month postdoctoral research project, September 2018-February 2020.

Abstract

Upslope stratigraphic traps, comprising deepwater sand bodies with updip terminations (pinchouts or erosional truncations) at their proximal end are a prime hydrocarbon exploration target in many deepwater basins including offshore Porcupine Basin. Examples of past discoveries inferred to have this type of trapping configuration include the Buzzard Field UK Central North Sea (~500 MMBO) and Marlim Field Brazil Campos Basin (~3000 MMBO). Whilst there is significant potential for further giant commercial discoveries, exploration is high risk principally due to the difficulty of predicting the presence of an effective sand pinchout: the resolution of conventional seismic means that thin sands, through which hydrocarbons can leak updip, are difficult if not impossible to detect.

A wealth of high resolution data from modern seafloor turbidite systems now exist and these can be used to better understand the locations of sand terminations and infer the processes responsible for their formation. Here we present examples of attached and detached turbidite systems from modern systems and models for stratigraphic pinchout development.

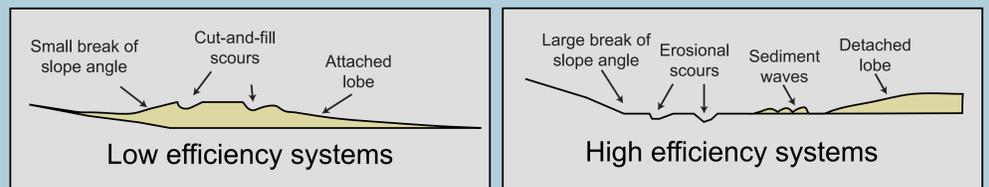
Future work will compile further examples in order to test if certain system or local factors (e.g., grain-size, slope gradient, morphology etc.) are positively associated with upslope sand terminations: and thus if these may be employed to help derisk the presence of stratigraphic closures in analogous subsurface systems.

The Problem:

- How, why, and when are deepwater sands connected to the sediment source?
- What can modern sedimentary systems tell us about the controls on fan attachment? Are seafloor observations consistent with detachment theories?
- How can we incorporate this information into risking of subsurface stratigraphic traps?

Theory:

- Attachment vs. detachment is an interplay between slope gradient, grain size, erosion, and other factors, which control the depositional processes present at the canyon mouth
- Turbidite fans can be classified into 'high efficiency' and 'low efficiency' systems:



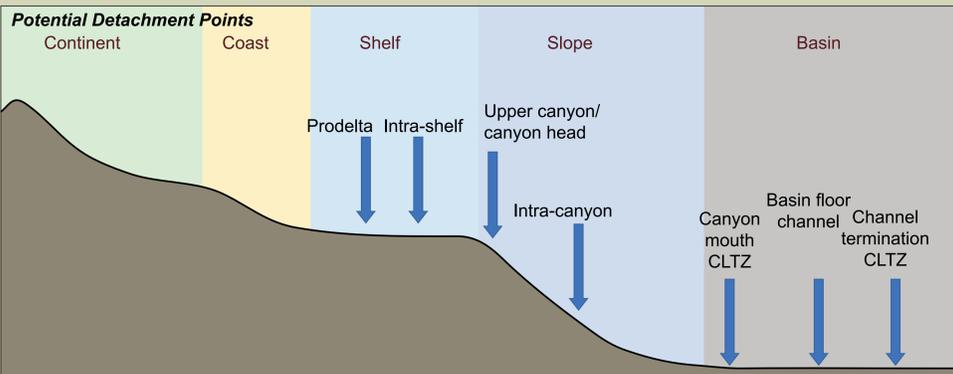
Wynn et al., 2002; based on Mutti and Normark, 1987

Are these models consistent with actual observations?

Issues to Address

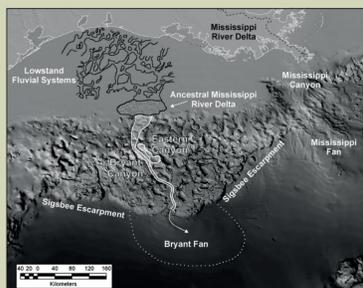
- Channel-Lobe Transition Zones (CLTZs): Do they actually result in detachment?
- Detachment models were initially based on outcrops- are these really detached? Are they detached for the reasons initially proposed?
- Are modern systems inherently biased due to highstand conditions? Can we separate out the controls on attachment from the evolution of the system through time?

Detached Systems: Examples



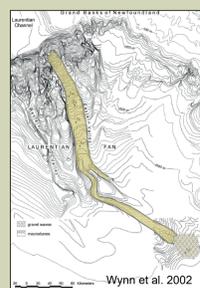
Shelf detachment points:

- Slope-sourced canyons with no clear connection with existing fluvial-deltaic systems
- Turbidites present may be the result of downslope evolution of MTDs
- May have been attached to deltas during previous lowstand



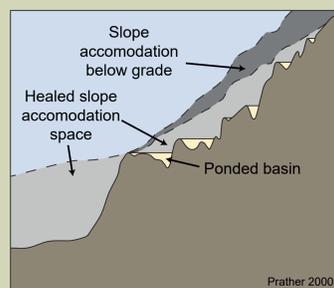
Canyon head detachment points:

- High-gradient slopes in upper reaches of canyons
- May be detached elsewhere



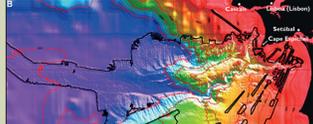
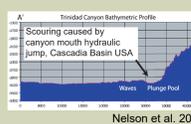
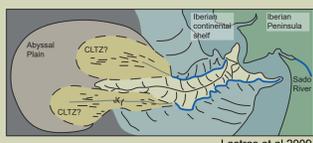
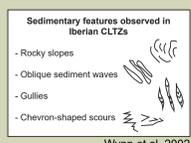
Intra-canyon detachment points:

- Result from stepped morphology within canyon or channel axis
- Bathymetric variations may have a structural or salt-tectonic origin
- Small ponded basins may be present within canyon/channel axis



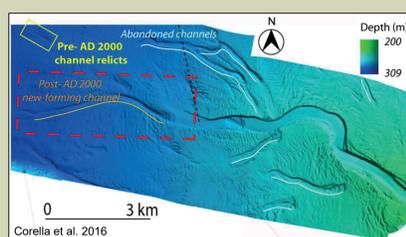
Canyon mouth and channel termination CLTZs

- Hydraulic jumps at canyon mouth lead to scouring and erosion
- Numerous examples, but do they result in detachment?

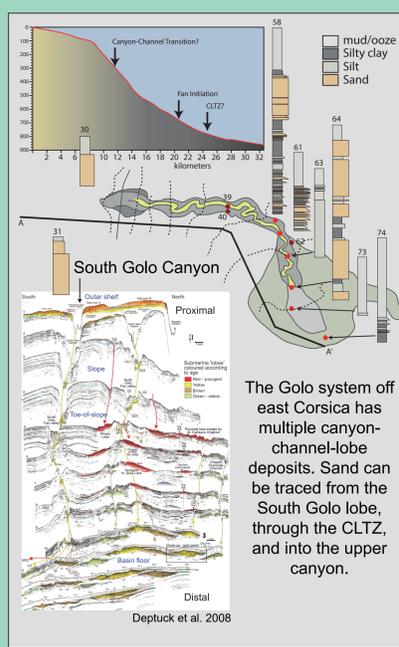


Intra-Channel Detachment

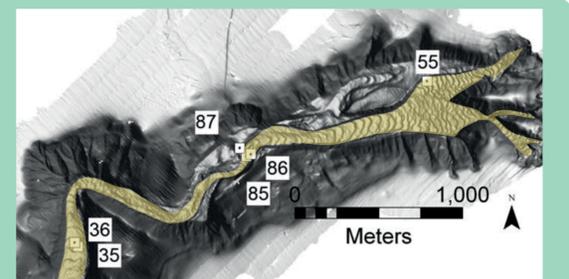
- Erosion of filled channel by nearby later MTDs
- Channel avulsion and abandonment from lobe switching or MTD blockage



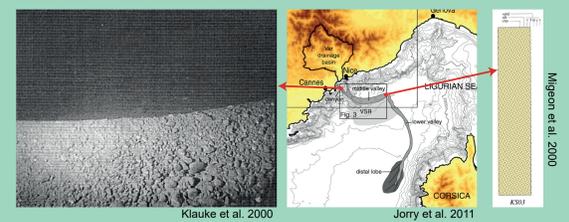
Attached Systems: Examples



The Golo system off east Corsica has multiple canyon-channel-lobe deposits. Sand can be traced from the South Golo lobe, through the CLTZ, and into the upper canyon.

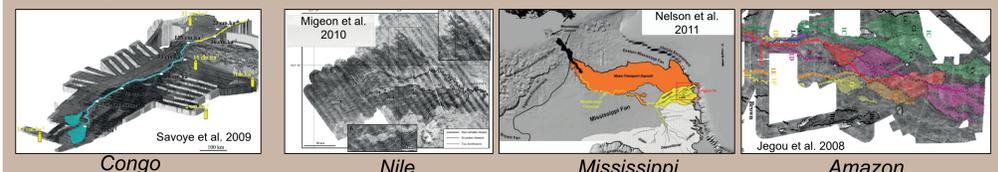


In the Monterey Canyon, sand can be traced from the canyon mouth to the canyon head and into the continental environment.



The Var submarine fan system is dominated by sands and gravels and extends hundreds of kilometers into the Mediterranean.

Other Systems: What is the Degree of Attachment?



These systems are large and well-studied, but how are they connected to the more proximal parts of the system? Connectivity may vary at different scales; e.g., individual lobes may be detached, but the system may be well-connected overall. Connectivity may also extend into the subsurface and be dependent upon past or future changes to the overall system (e.g., sea level). A critical part of addressing these questions is obtaining data across all parts of multiple systems.

Future Plans:

- Review existing published data
- Access seafloor data from other institutions in order to answer specific questions
- Incorporate data from seismic and outcrop
- Seismic modeling?

Acknowledgements

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