# Volumetric Considerations for Deepwater Pinchout Traps

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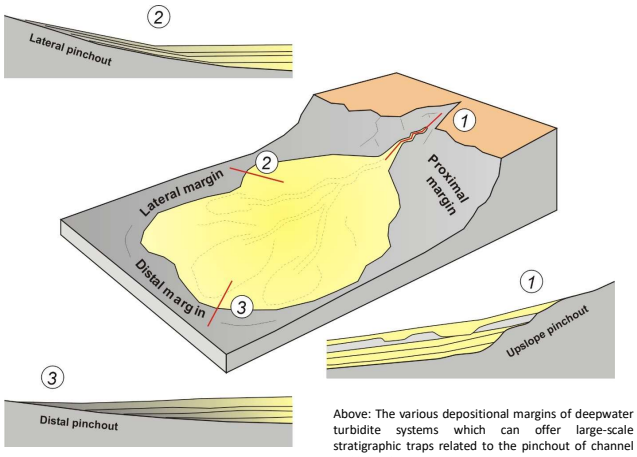
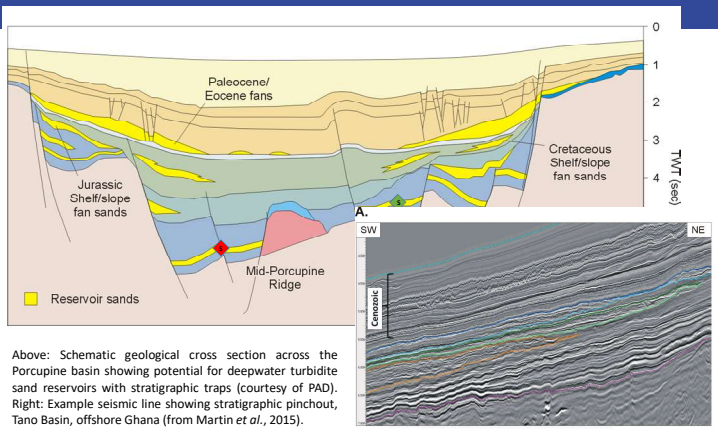
## 1) Introduction

- Stratigraphic traps formed by pinchout of turbidite sandstones at the margins of deepwater basins are an important global target for exploration in frontier basins including the Porcupine Basin.
- Giant discoveries are necessary for commercial success in many deepwater basins where drilling and development costs are substantial.
- Simple geometric models are considered here to better understand the volumetric potential of stratigraphic pinchout traps notably the constraints imposed by column height and dip angle.




Above: The various depositional margins of deepwater turbidite systems which can offer large-scale stratigraphic traps related to the pinchout of channel and lobe elements.




Above: Schematic geological cross section across the Porcupine basin showing potential for deepwater turbidite sand reservoirs with stratigraphic traps (courtesy of PAD). Right: Example seismic line showing stratigraphic pinchout, Tano Basin, offshore Ghana (from Martin *et al.*, 2015).

## 2) Estimated Ultimate Recoverable Resource

- Stock tank oil initially-in-place (STOIIP) and estimated ultimate recovery (EUR) can be estimated from the following:

$$STOIIP = GRV.NTG.PHI.S_o.\left(\frac{1}{FVF}\right)$$

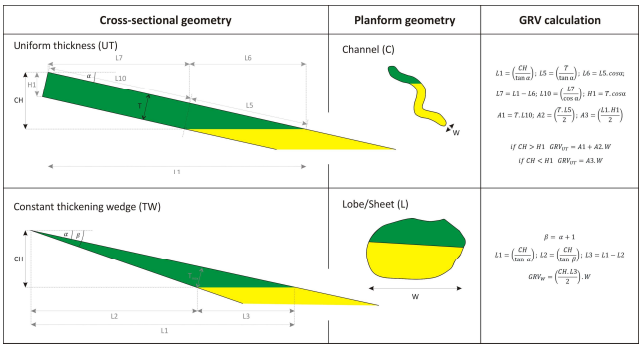
$$EUR = STOIIP.RF$$

*Variable: gross rock volume (GRV), net-to-gross (NTG), porosity (PHI), oil saturation (So), formation volume factor (FVF) and recovery factor (RF)*

- GRV filled by hydrocarbons is the single most important input since it can vary by many orders as governed by reservoir thickness (T), extent and geometry as well as hydrocarbon column height (CH) and reservoir dip angle.

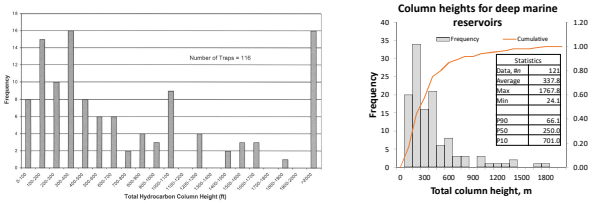
## 3i) Model Inputs - *Geometric models for reservoirs*

- For GRV calculation we consider two end-member cross-sectional geometries *i)* a dipping rectangle ('UT model') and *ii)* a dipping wedge ('TW model') and two planform geometries *a)* 1 km wide channel and *b)* 5 km wide lobe.




## *Column heights*

- Column heights can be large - over 2 km for some stratigraphic traps (e.g., as reported by Allan et al. 2006).
- For deepwater turbidite reservoirs median P50 values are of order ~250 m with somewhat lower values for known upslope, lateral and distal pinchout traps.







Left: Total column heights (oil and gas) for stratigraphic and subtle combination traps reported by Allan *et al.* (2006). Right: Same for deep marine turbidite reservoirs of all trap types from C&C DAKS database.

## *Choice of other parameters*

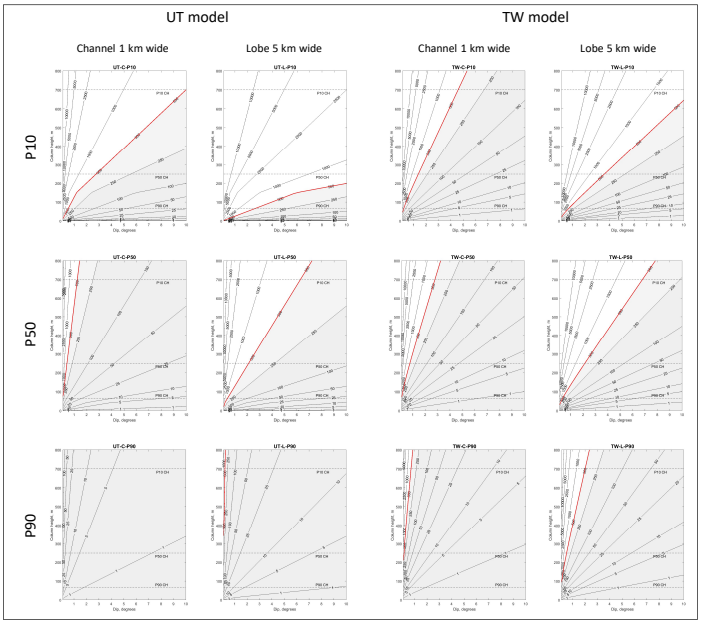
- Other parameters used for EUR calculation were determined from statistics for deepwater turbidite reservoirs with NTG set to 1.

| *Pn* | *T* | *NTG* | *PHI* | *So* | *FVF* | *RF* |
|---|---|---|---|---|---|---|
| P10 | 152 | 1 | 0.31 | 0.85 | 1 | 0.55 |
| P50 | 43 | 1 | 0.24 | 0.72 | 1.1 | 0.38 |
| P90 | 12 | 1 | 0.1 | 0.55 | 1.2 | 0.15 |

Above: Thickness, net-to-gross, porosity, oil saturation, formation volume factor and recovery factor for deepwater turbidite reservoirs (from C&C DAKS database).

## 4) EUR Results

- Results for EUR in MMbbls are shown below as contour plots as a function of dip angle and column height.
- Red line indicates 500 MMbbl contour – approximate guide for commercial discovery in a deepwater frontier basin – and grey shading highlights EUR < 500 MMbbl.




Above: Variation in EUR (MMbbl) with dip angle and column height for UT and TW models, in both channel and lobe configuration, using P10, P50 and P90 parameters. Horizontal dashed lines indicate P10, P50 and P90 column heights based on global deepwater turbidite reservoirs of any trap type.

## 5) Implications for Exploration

- Simple models as presented here help constrain the likely occurrence of giant oil accumulations indicating constraints imposed by reservoir dip; even modest angles can severely constrain resource potential especially in the case of narrow slope channel systems.
- Results are particularly pertinent to upslope traps on proximal channelized margins where relatively steep initial 'depositional' slopes and low net-to-gross systems may be needed to aid pinchout development but act to limit hydrocarbon volumes.
- Pinchout traps at lateral and distal margins of basins comprising lobe/sheet systems, where steep primary depositional slopes are not required for pinchout development, may hence offer better resource potential (assuming limited structural tilt and suitable net-to-gross).
- Whilst resource volumes of individual prospects must be considered on a case by case basis with detailed mapping, simplified approaches as used here can help initial basin screening and identification of margins with the potential for giant hydrocarbon accumulations.

**Reference:**
Allan *et al.* (2006) Geol. Soc. London, Spec. Pub., v254, p57–103.
Martin *et al.* (2015) GEOExpro, v12, p28-30.