Sand Body Thickness Variations in the Outer Fan and Fringe of a Fine-Grained Deepwater Fan: Implications on Reservoir Characteristics of Turbidite Sands*

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Abstract

Outcrop studies of the Permian Skoorsteenberg Formation in the Tanqua Karoo sub basin of South Africa yield an applicable example of fan termination characteristics in the outer sheet sands that exhibit a digitate morphology near the fringe. Massive fine-grained sandstone deposits of the outer fan are evidence of significant sediment bypassing (70-90%) to the distal fan area. Hydrocarbon reservoirs can be found in all the architectural elements of submarine fan deposits in the Gulf of Mexico and around the world, including the outer fan fringe deposits. Routine examinations of seismic and well log data may not properly delineate these types of reservoirs.

Once the head of a turbidity current becomes higher than the levee crests, overflowing will commence, forming oblong sheet sands. Outer fan architecture shows that the onlapping of sheet sands result in massive sand bodies. Gradual loss of sand forces the current to separate into lobe fingers resulting in irregular seafloor topography.

Examinations of outcrops in the Tanqua Karoo indicate that vertical variations in bed thickness can range from 42 cm (1.4 ft) to 7 m (23 ft). The flat basal contact of sandstone layers in the outcrops, together with the near lack of amalgamation, scouring, and rip-up clasts in the sandstones, suggest that the seafloor bathymetry has a dominant control on the sand body geometry. Onlapping of sheet sands or bifurcation of sand lobes will not be noticed on seismic records unless specific attention is used.

Selected References

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Introduction

- Outcrop study of outer fan fringe
- Hydrocarbons found in all turbidite elements
- Exploration emphasis on channels
- Sediment bypassing may deliver sand to distal elements
- Sand volume unknown in outer fan fringe

Introduction

- Outcrops of this distal portion commonly eroded
- Depositional architecture and sand body variability not well described

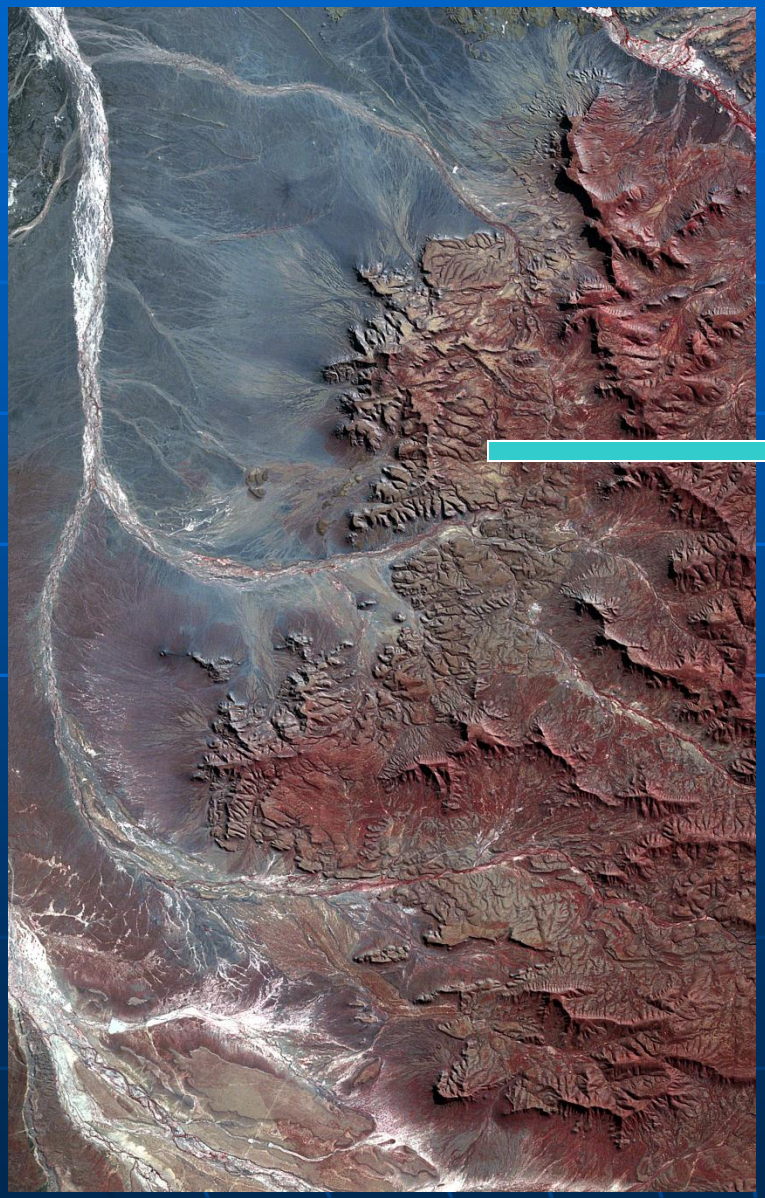
Purpose:

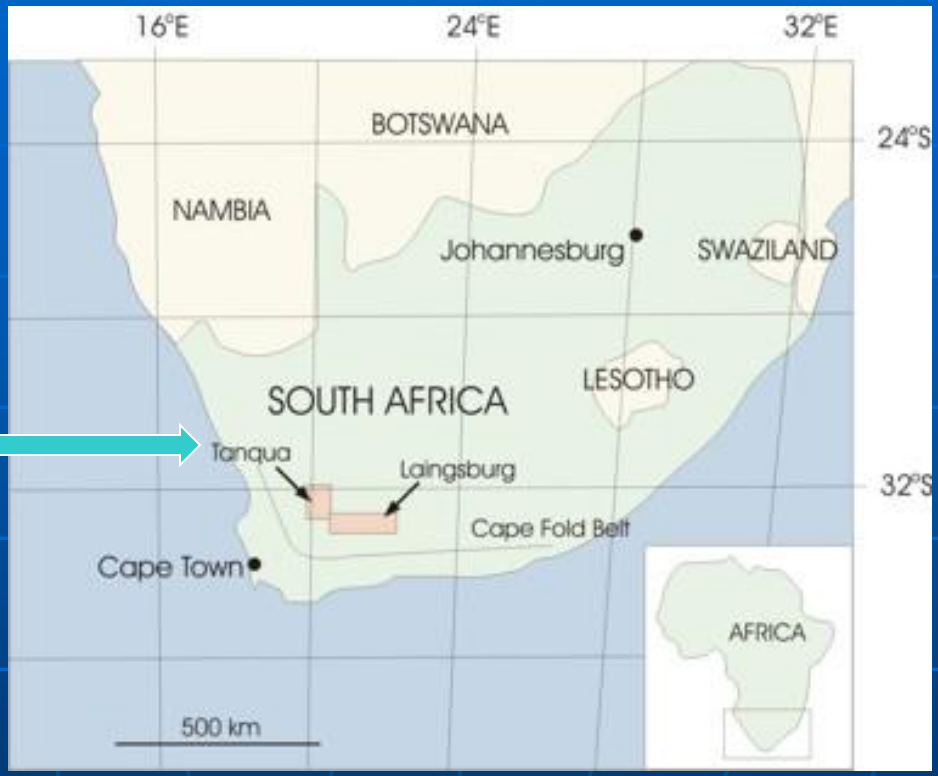
- To shed light on this distal element
- Outcrop analysis from Tanqua Karoo in South Africa

Tanqua Karoo

- World-class outcrop of fine-grained turbidite deposits
- Five fans in submarine fan system
- Several studies during over a decade of research
- Details summarized in AAPG Memoir 68/SEPM Special Pub. 72

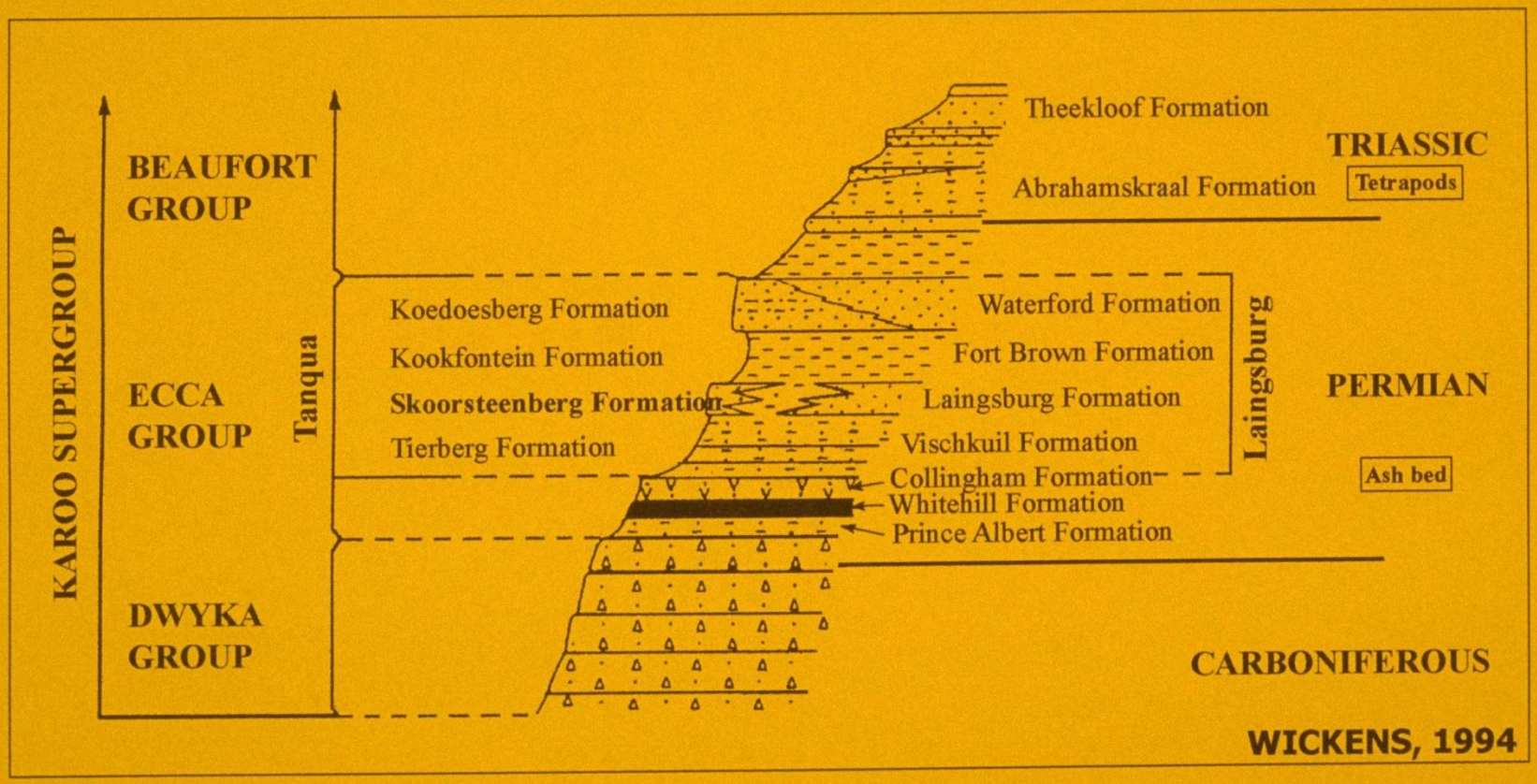
Study Area

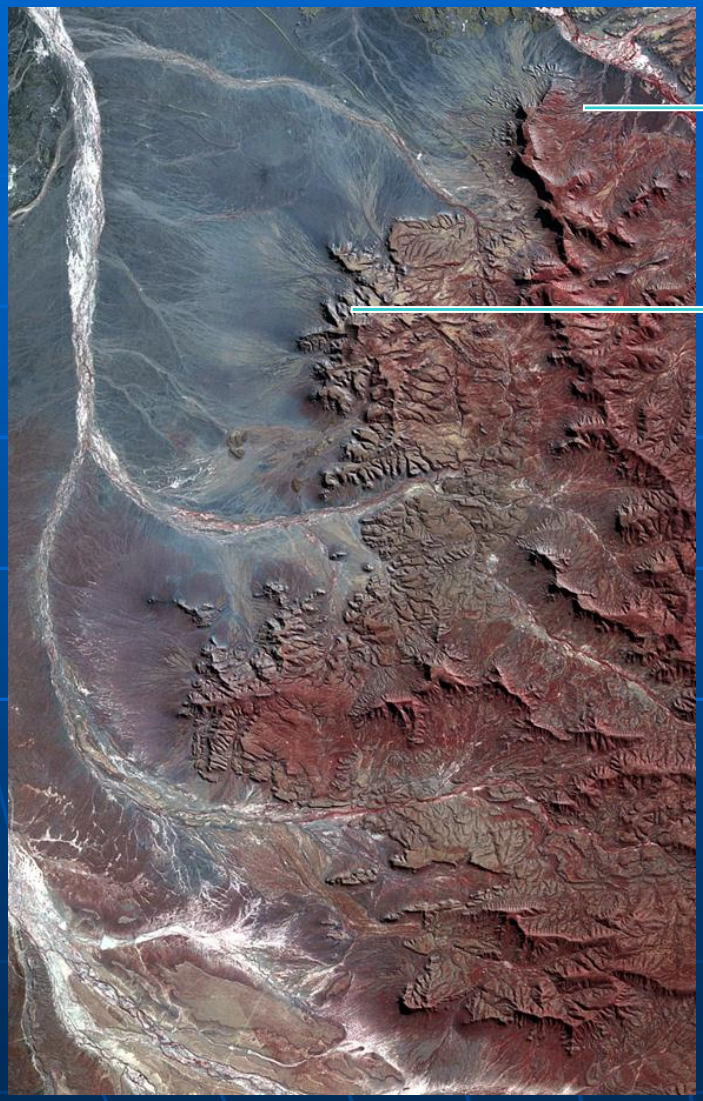


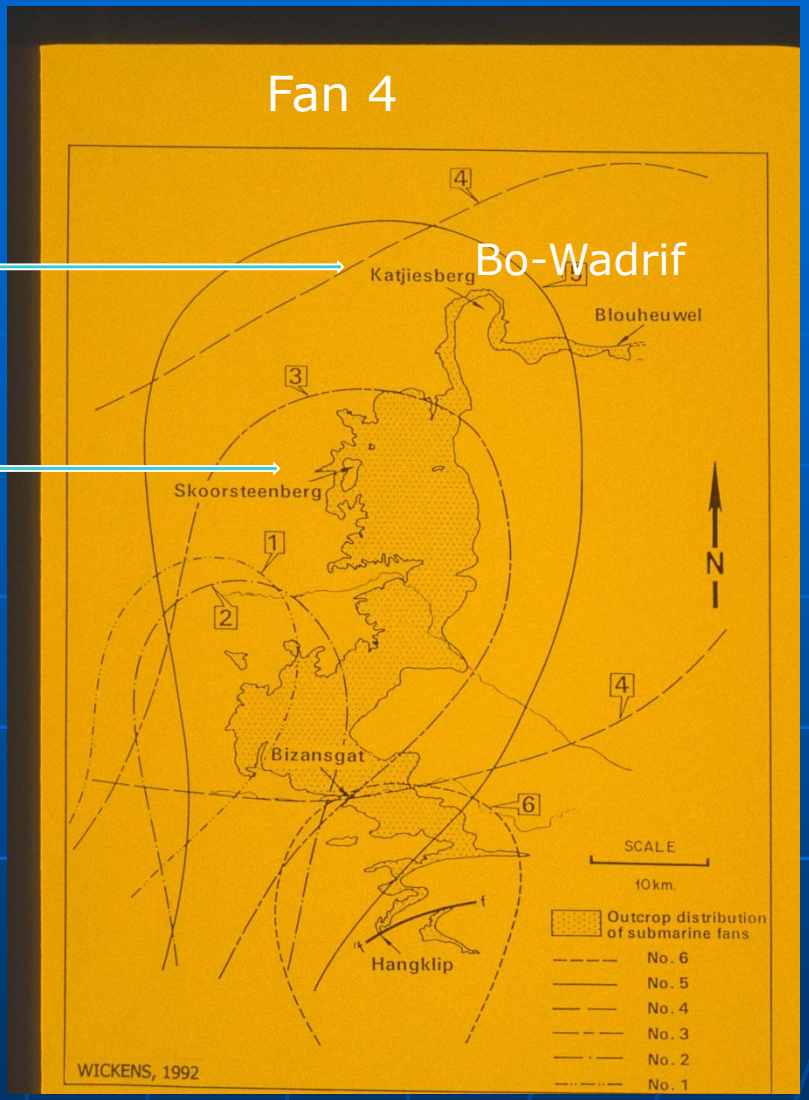


(King et al., 2003)

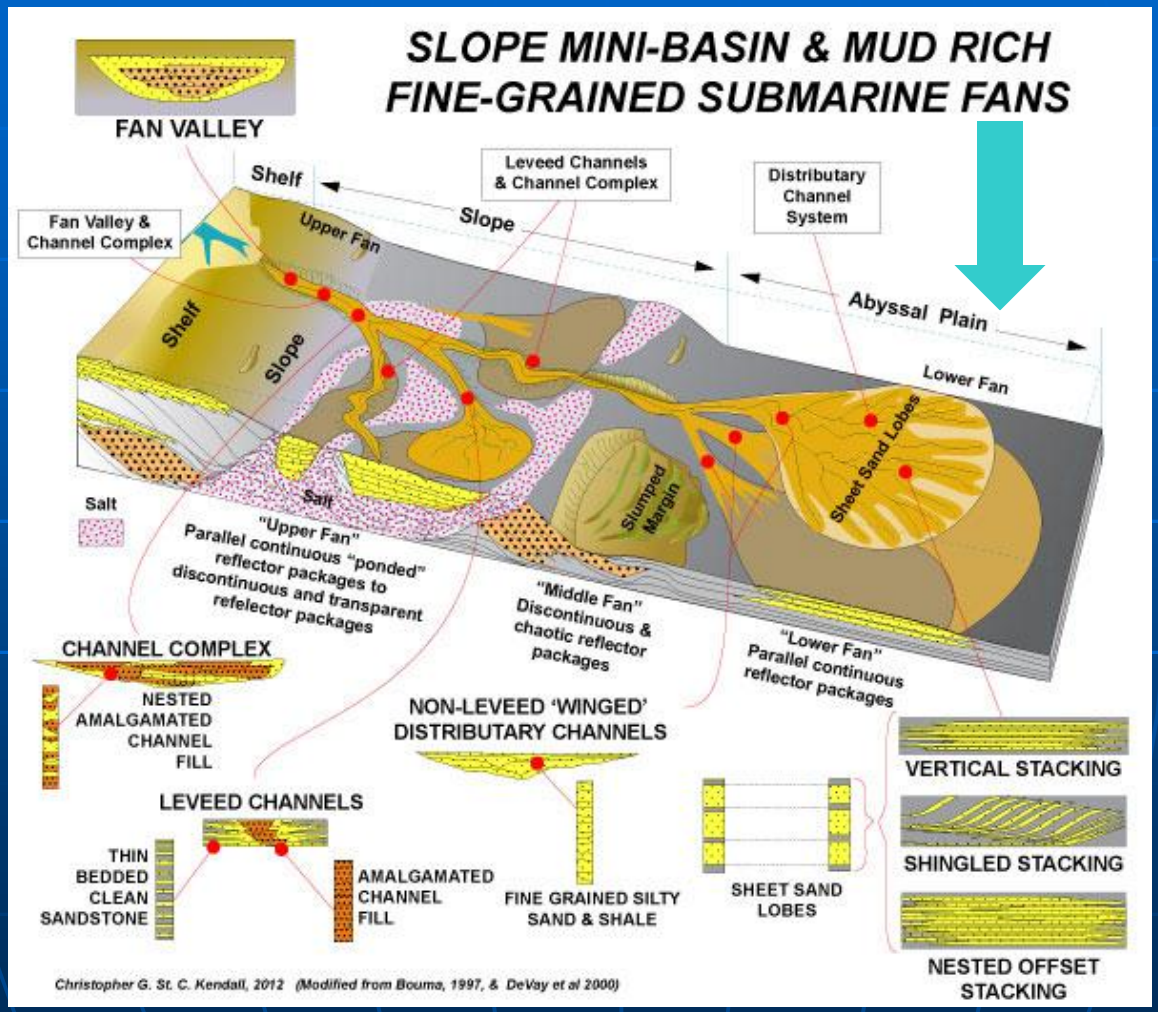
REGIONAL STRATIGRAPHY






Fan 4
Bo-Wadrif
Katjiesberg
Blouheuwel
Skoorsteenberg
Bizansgat
Hangklip
4
3
2
1
6
N
SCALE
10km.
Outcrop distribution of submarine fans
No. 6
No. 5
No. 4
No. 3
No. 2
No. 1
WICKENS, 1992

Fan 4 Depositional Lobe

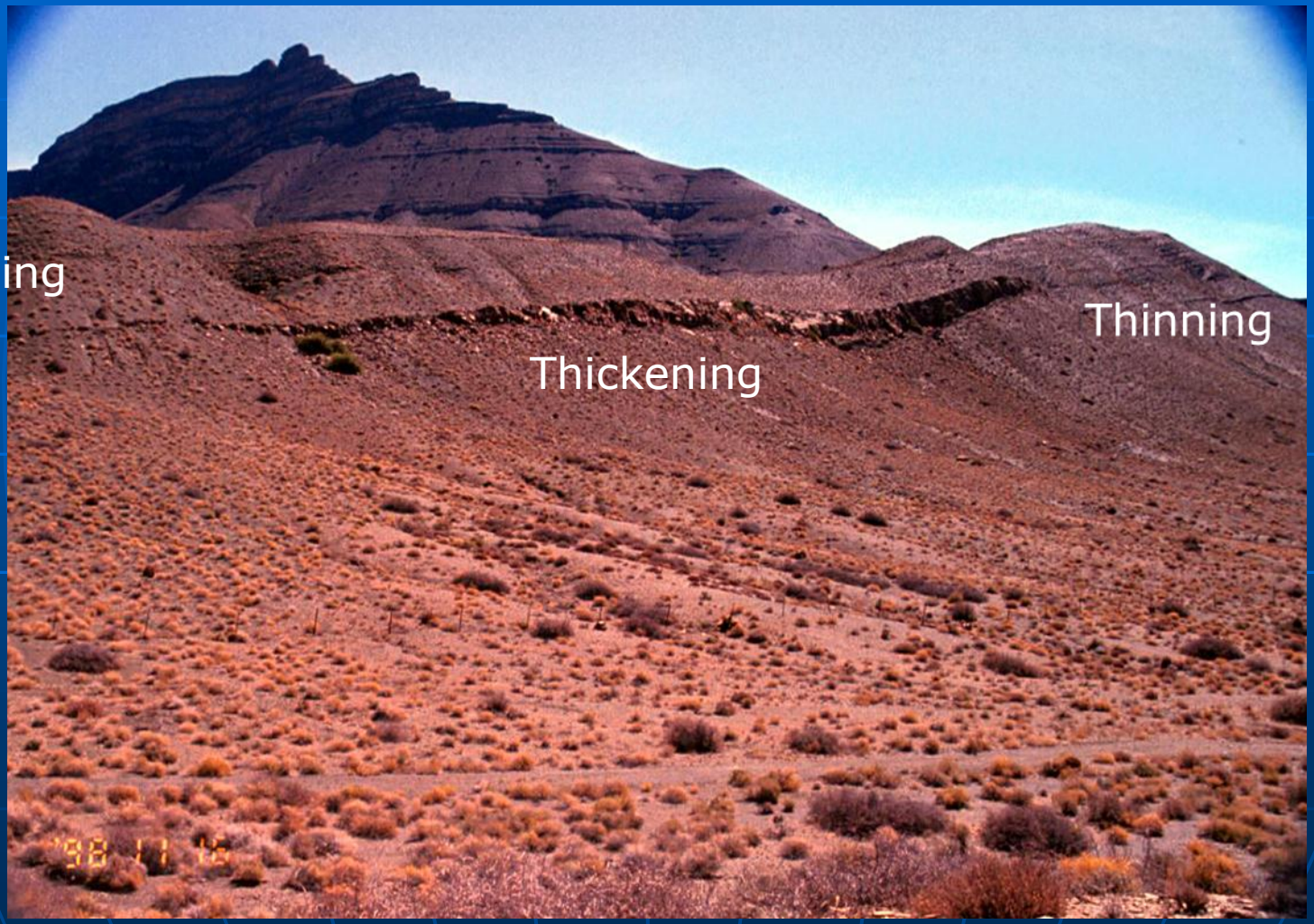


Kendall, 2012 (modified from Bouma, 1997 and Devay et al., 2000)

Outcrop Vicinity of Bo-Wadrif

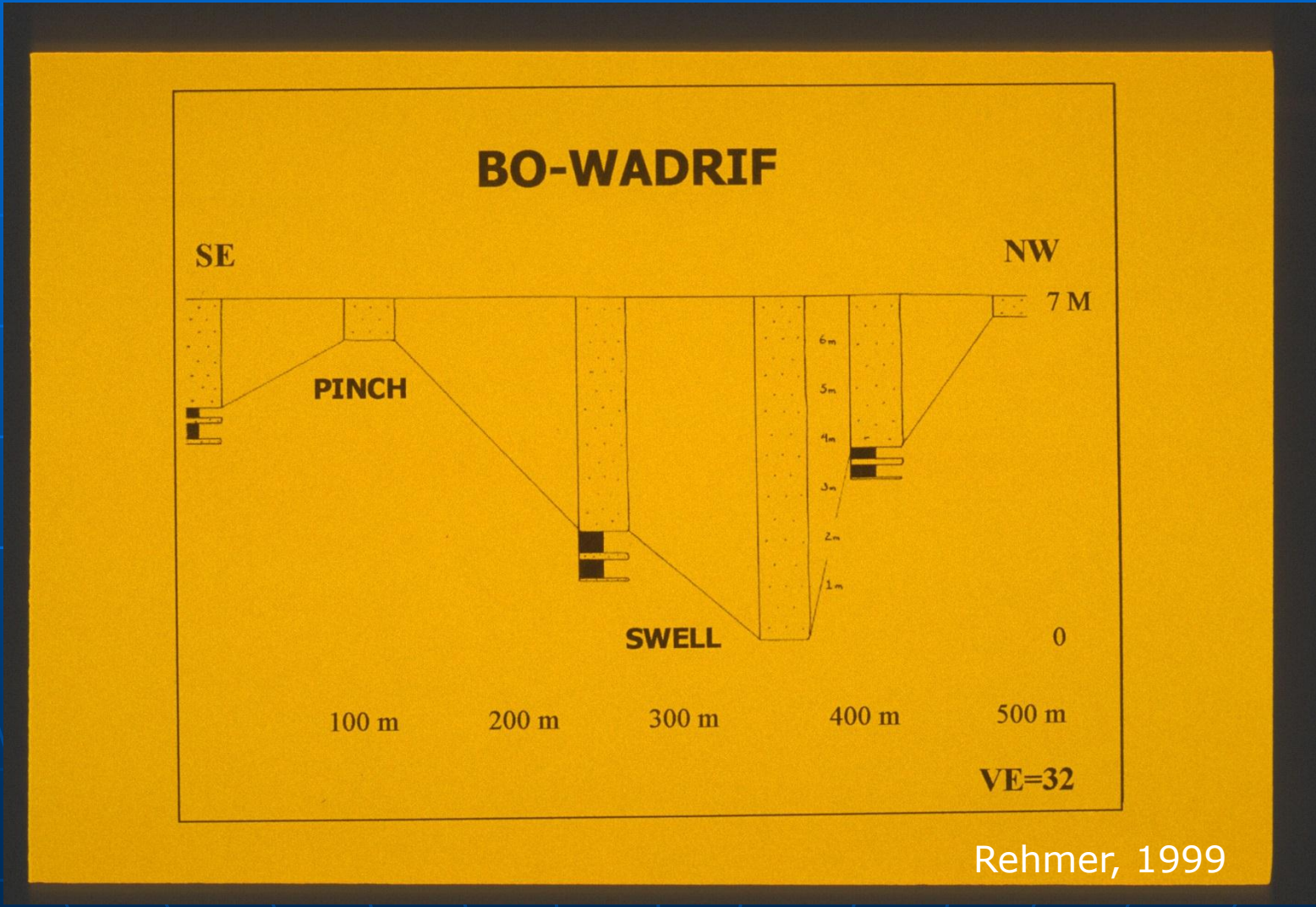
(Bouma, helicopter photo 1998)

Annotated View of Bo-Wadrif



(Bouma, helicopter photo 1998)

Measured Sections



Rehmer, 1999

Discussion

- Excellent example of outer fan fringe deposit
- Highly variable sandstone thickness from 7 m to less than 0.5 m
- Lateral distance of outcrop is 0.5 km
- Pinch and Swell sand body geometry
- 3 to 4 cycles of pinch and swell across lateral extent of exposure

Discussion

- Erosion may have obscured the plan view depositional geometry
- Hypothesis that lobe may bifurcate into lobe fingers at or near the termination
- Topographic lows may amplify the variations in sand body thickness
- Bifurcation may be caused by variations in the frictional forces acting on the current or;
- They may be caused by variations in seafloor topography
- Flat nature of basal contact thought to support a frictional variation

Reservoir Implications

- Pinching of sand bodies between well spacing
- Observations at Bo-Wadrif support concept of sediment bypassing to distal portion of fan
- Presence of sand itself counters notion that the outer fan fringe is dominated by clay
- Identification of outer fan fringe could lead to thicker continuous sand bodies in the proximal portions of the fan

Conclusions

- Bo-Wadrif outcrop is unique example of an outer fan fringe deposit
- Termination at the distal portion of a fan rarely preserved due to erosion
- Thickness variations imply lobe bifurcation near the terminus
- Reservoir implications at outer fan fringe
- Further well bore, seismic and outcrop studies necessary

Acknowledgements

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