

# **Paleogeographic Reconstruction and Characteristic Trends of a Basin Floor Fan in Los Molles Fm., Neuquen Basin, Argentina: Enhanced Coarse-Grained Fan Model Using 3D Outcrops\***

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## **Abstract**

The Jurassic deep-water marine deposits of Los Molles Fm in Neuquén Basin, Argentina (La Jardinera area) have received much attention through the years; however, a detailed characterization of the basin floor fans that outcrop in the area was missing. We made use of a high-resolution satellite image, drone imagery and 3500 m of logs with detailed measurements to build isopach and net/gross (NG) maps that with facies analysis helped reconstruct the evolution of the system. In addition, grain size, facies and bed thickness trends were useful to refine the interpretation at a lobe scale in unit LC3. Lithofacies, NG ratios and sandstone bodies' geometries help defined six facies association: hemipelagic deposits, fringe lobes, off axis lobes, on axis lobes, distributary channels and debris flows. The facies associations define lobe elements that are grouped into lobes (<10 m thick) and these into lobe complexes (~20-40 m thick). The studied basin floor fan comprises five lobe complexes (LC1-5) separated by fine-grained intervals. Here, we evaluated only LC1-4, since LC5 is poorly exposed. LC1 shows paleoflows towards the north and another one towards the east; it is composed of two lobes with high proportion of unconfined deposits. LC2 shows northeastward paleoflows, it is composed of three lobes that onlap and fill relative low areas left by LC1. LC3 exhibits paleoflows to the east and it is composed of six lobes, five of which show channels on their axis, evidencing the most proximal setting on the system. The lobes of LC3 aggrade and migrate laterally towards the NW. LC4 develops on top, with its axis shifting to the south and backstepping, exhibiting only unconfined lobe elements. Detailed study of lobes 2 and 3 in LC3 show interesting trends in axial sections. Proximal to lobe axis beds are thicker (>40 cm), grain size is greater (medium sand to granules) and main facies are conglomerates and structureless sandstones. Off axis, beds are thinner (<40 cm), grain size ranges from fine to medium sand and there is an increase on normally graded and laminated sands. These trends are associated with the confinement and density of the flow. From lobe axis to off-axis, channelized elements disappear, and the facies vary from high density to low density turbidites. The present work shows that Los Molles Fm has significant sandstone units that likely form good reservoirs when present in the subsurface and a good analog for coarse-grained fan deposits.

### **Selected References**

Franzese, Juan R., and Luis A. Spalletti, 2001, Late Triassic early Jurassic continental extension in southwestern Gondwana: tectonic segmentation and pre-break-up rifting: *Journal of South American Earth Sciences*, v. 14/3, p. 257-270, doi:10.1016/S0895-9811(01)00029-3

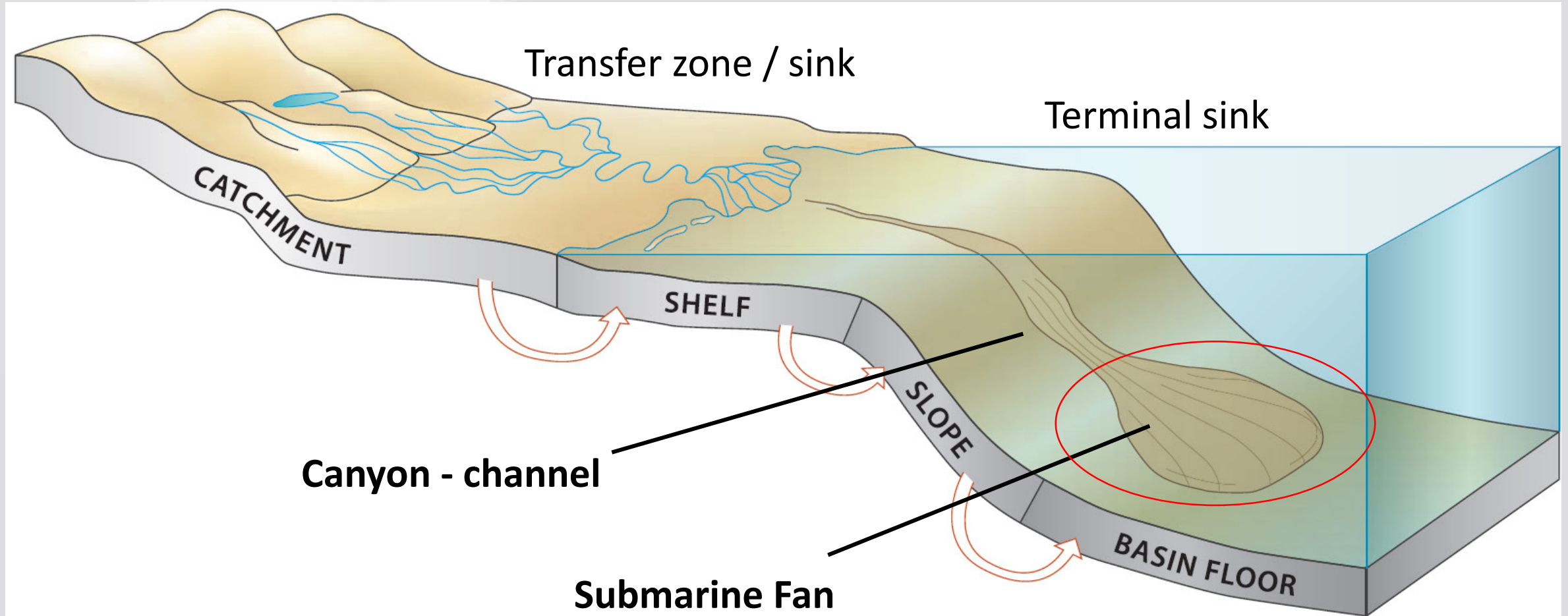
Reading, H.G., and M. Richards, 1994, Turbidite systems in deep-water basin margins classified by grain size and feeder system: *AAPG Bulletin*, v. 78, p. 792-822.

Tudor, E.P., 2014, Facies Variability in Deep Water Channel-to-Lobe Transition Zone: Jurassic Los Molles Formation, Neuquen Basin Argentina: M.S. Thesis, University of Texas at Austin, 90 p.

# Paleogeographic reconstruction and characteristic trends of a basin floor fan in Los Molles Fm., Neuquén Basin, Argentina

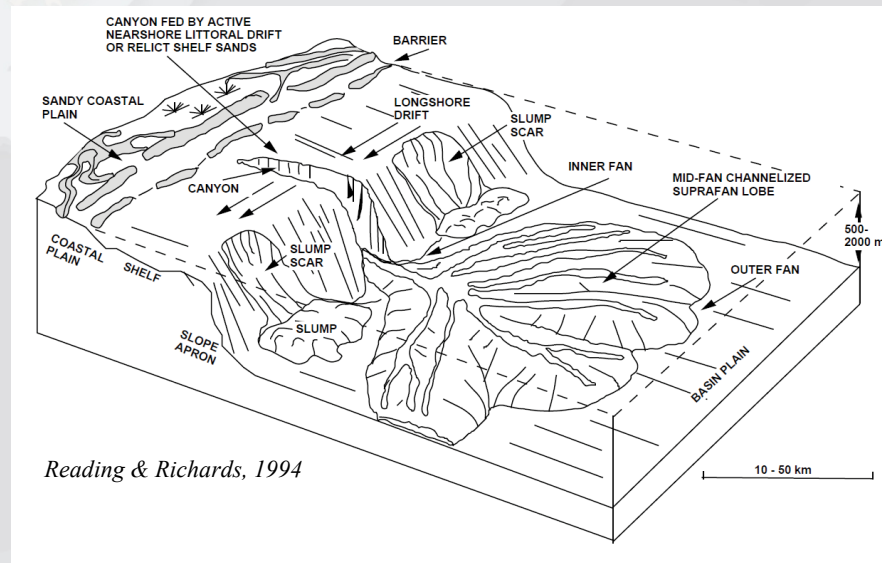
*Enhanced coarse-grained fan model using 3D outcrops*

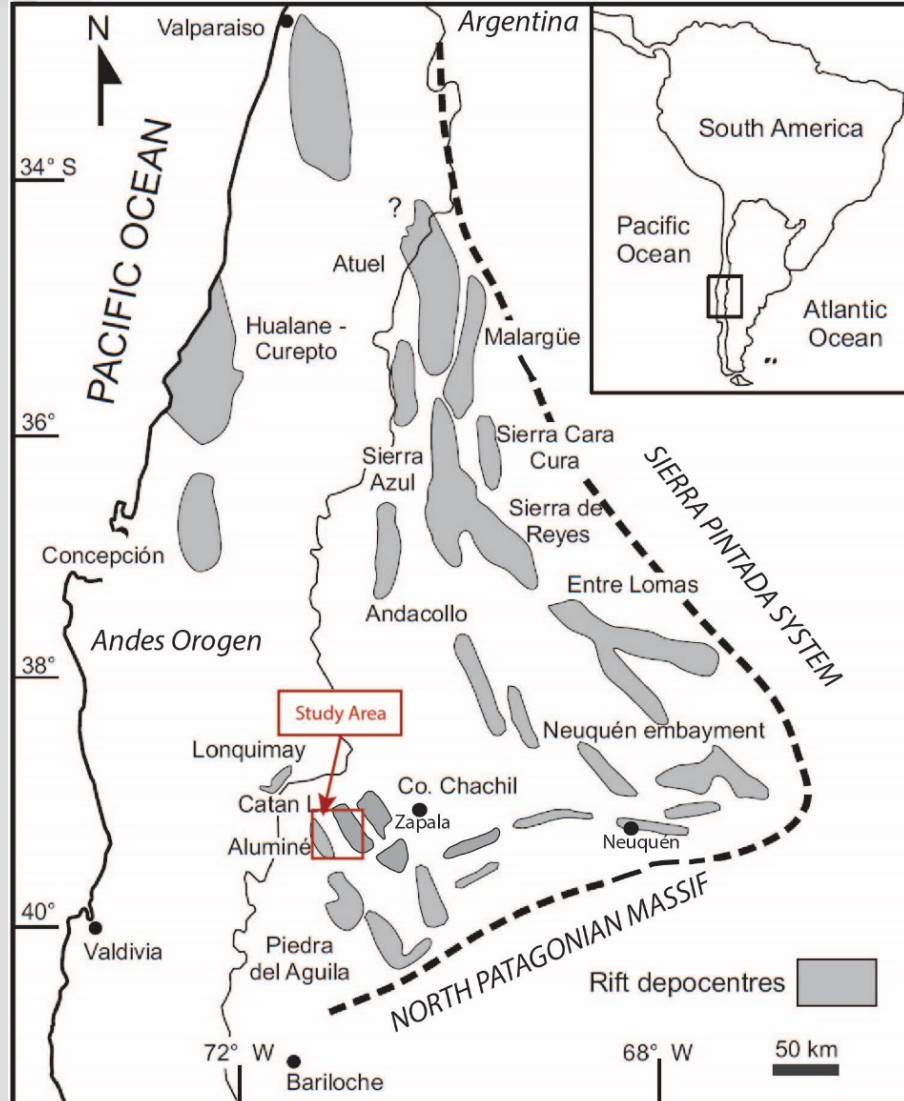
Source



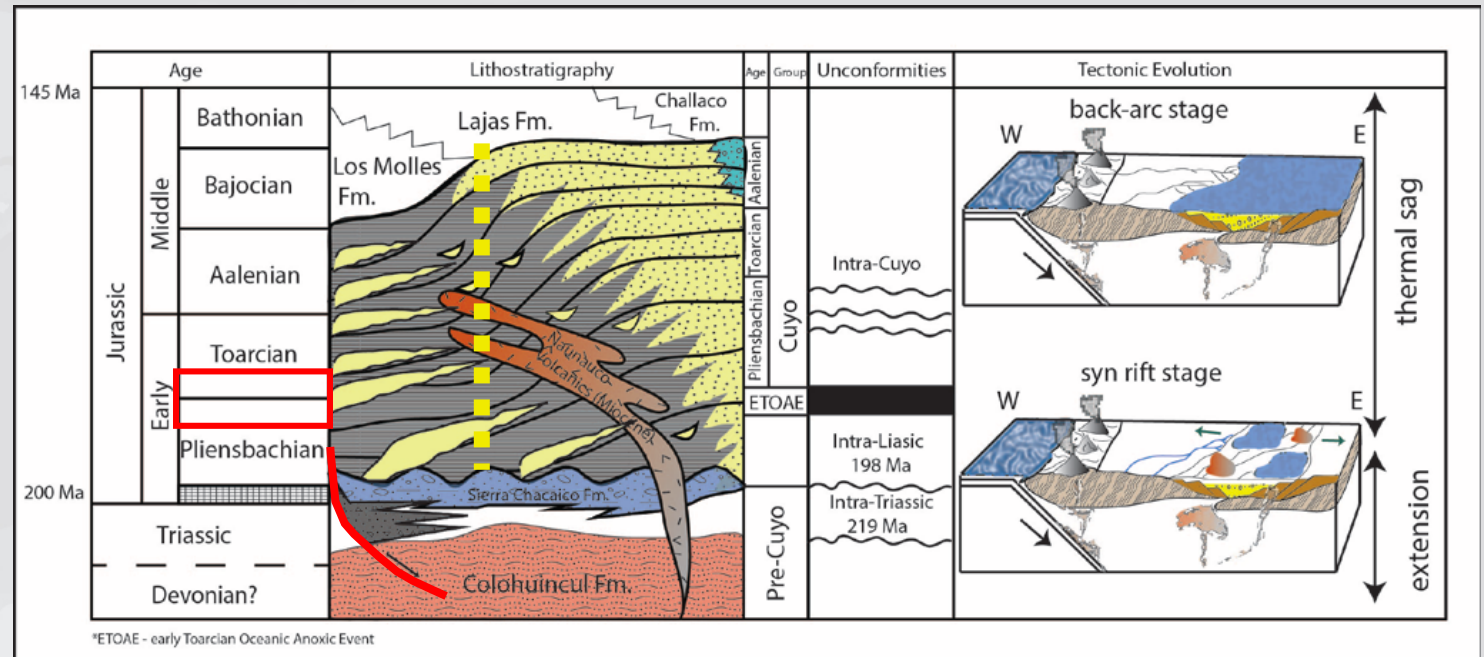


- What's the architecture and hierarchy of the different components within this coarse-grained fan?
- Are there any trends that might tell us something about the position in the fan?
- **Important to build new models of coarse-grained systems!**

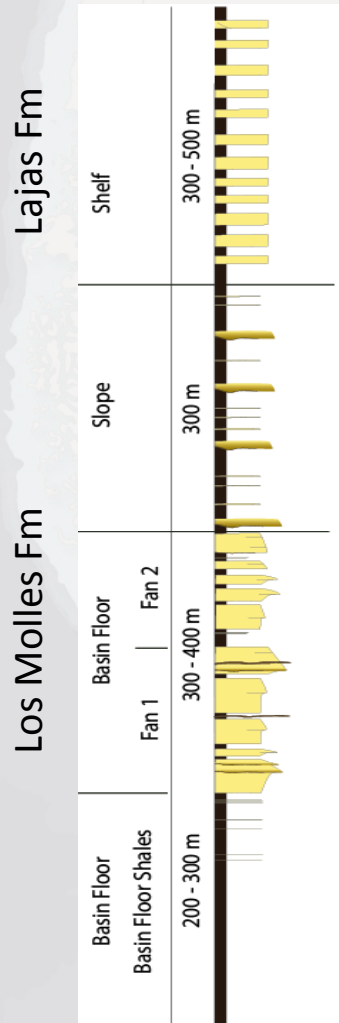




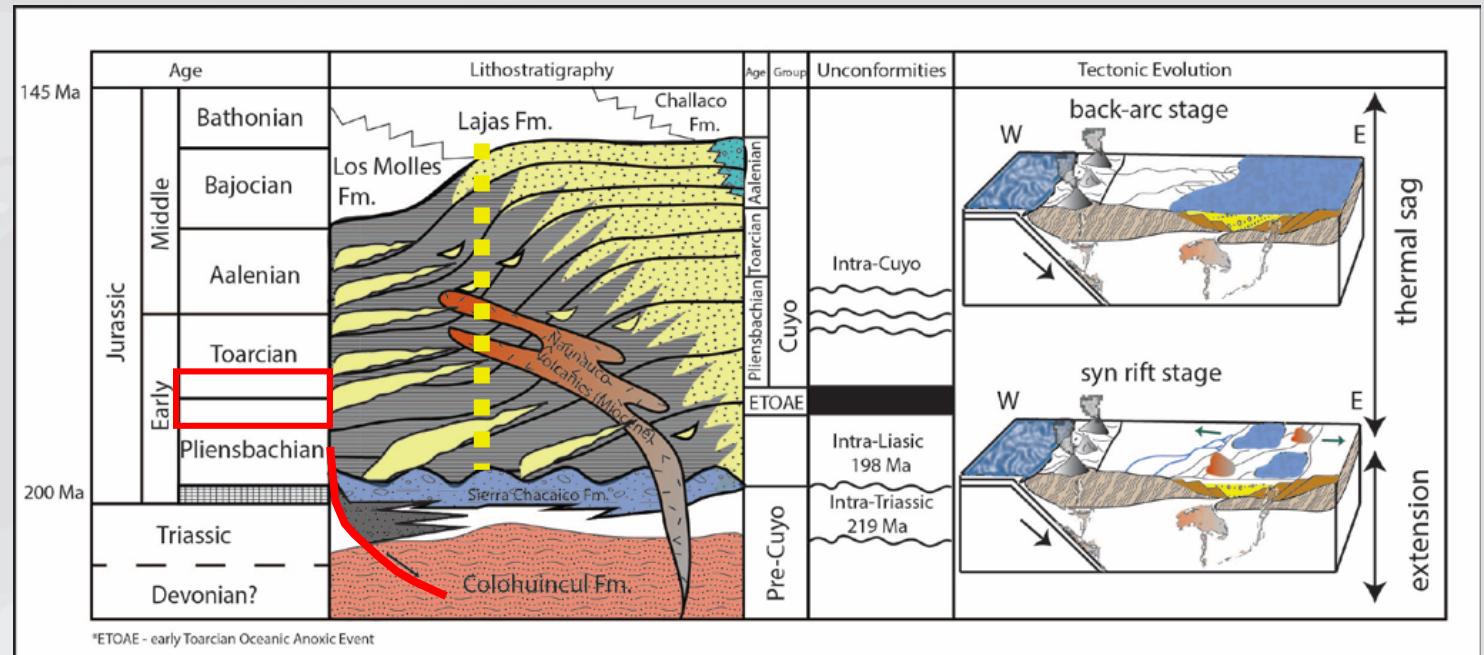
## Stratigraphy



## La Jardinera type log

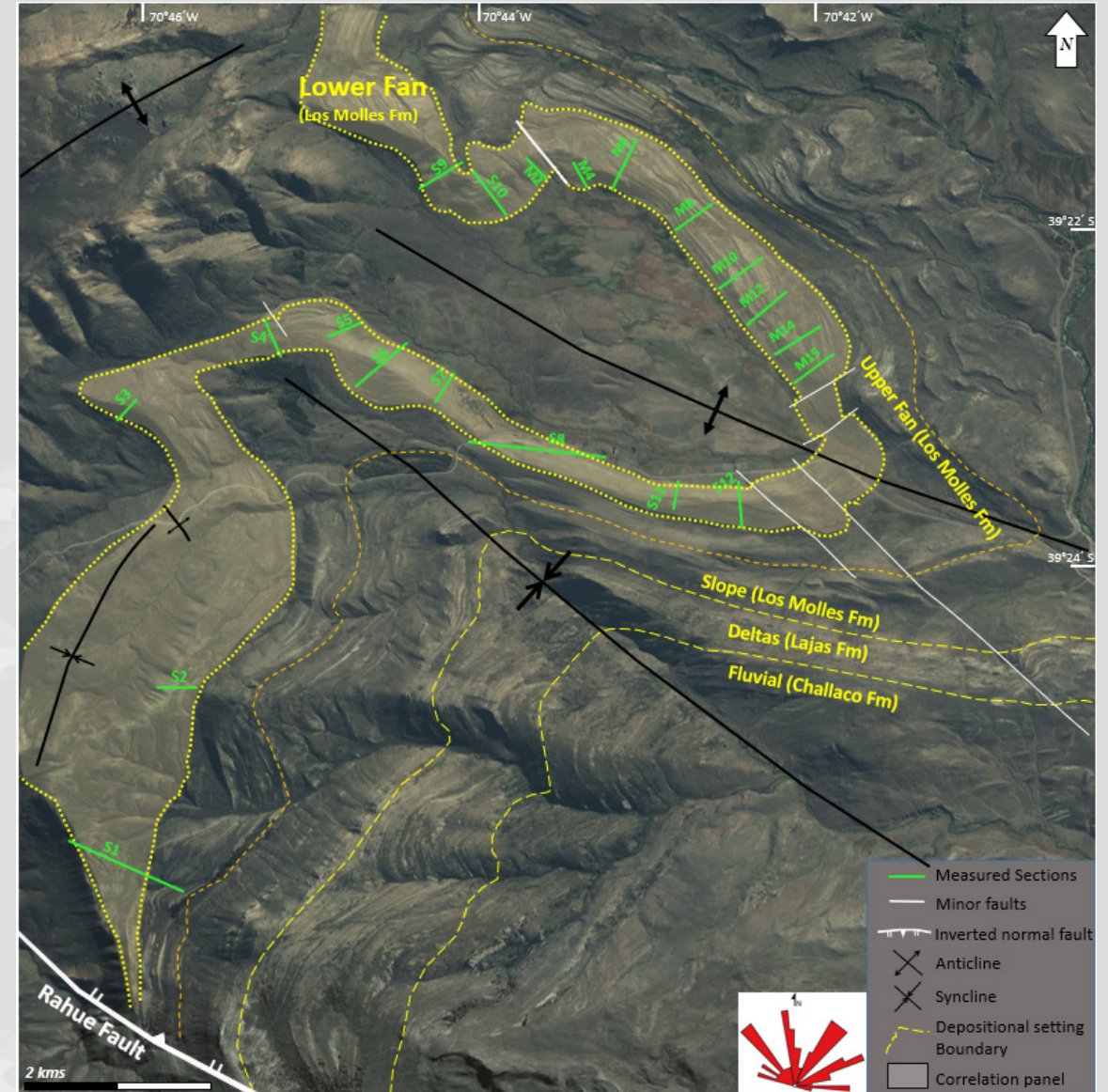


## Stratigraphy





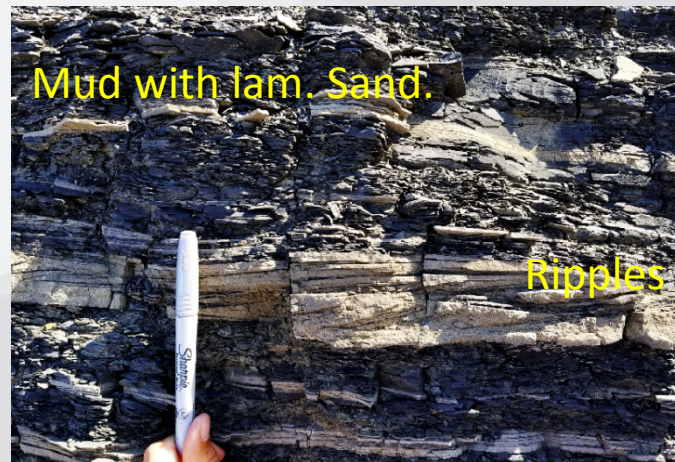
- 20 sections measured in detail with a total of 4000 m
- 62 Paleocurrents
- Grain size
- Bed thickness and geometry
- Drone imagery
- DEM + sat. image
- 8 sections measured by a former UT student (Shin, 2015)



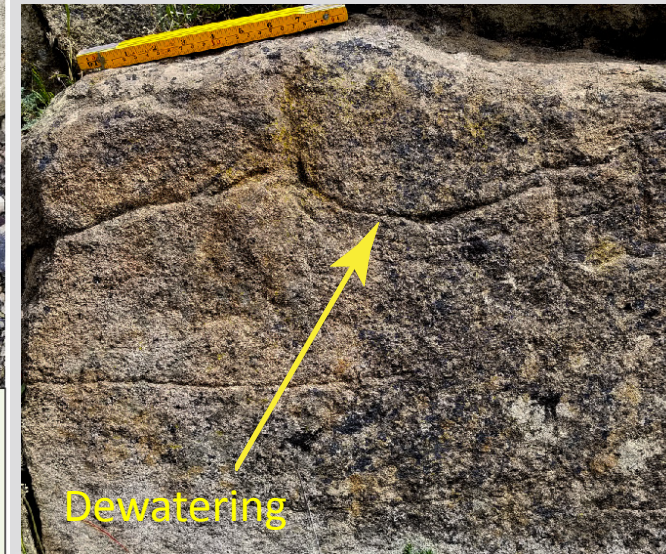
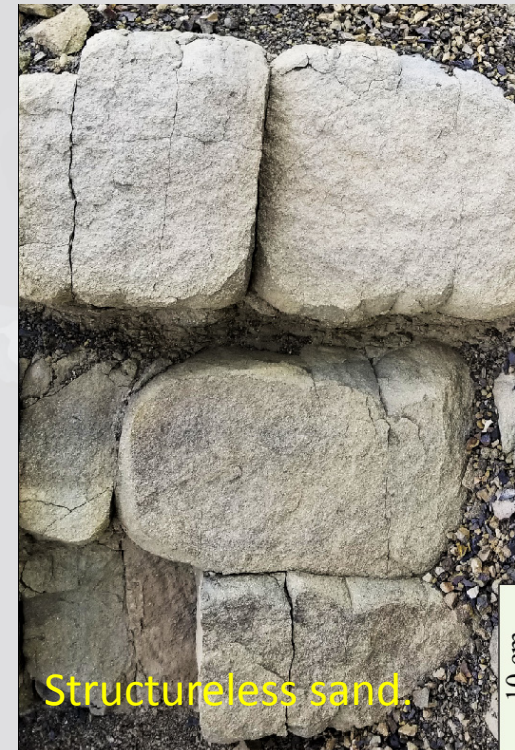
Modified from Paim et. al., 2008



## Low Density Turbidites

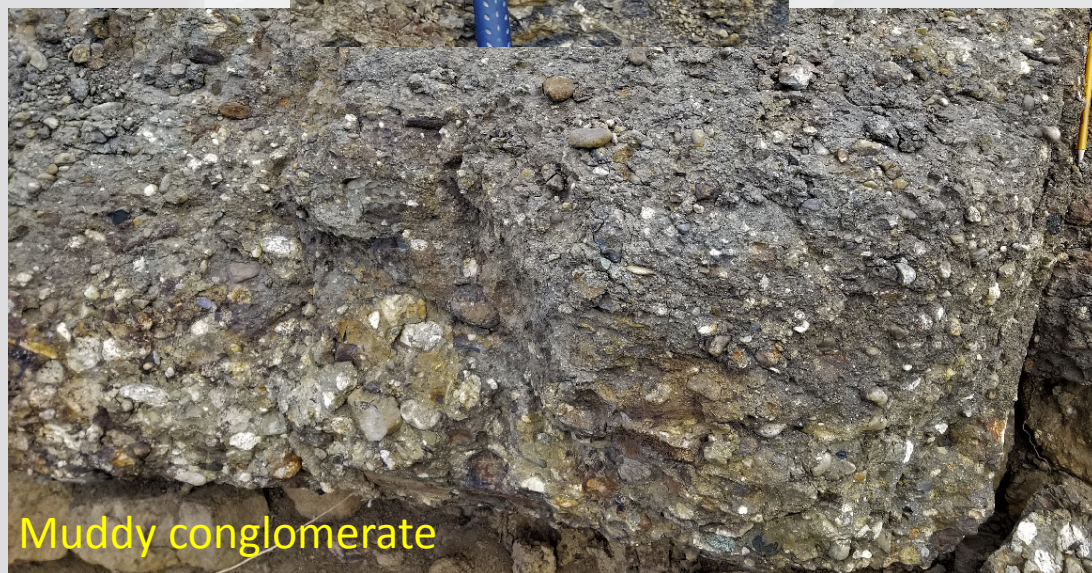


## High Density Turbidites





## Debrite

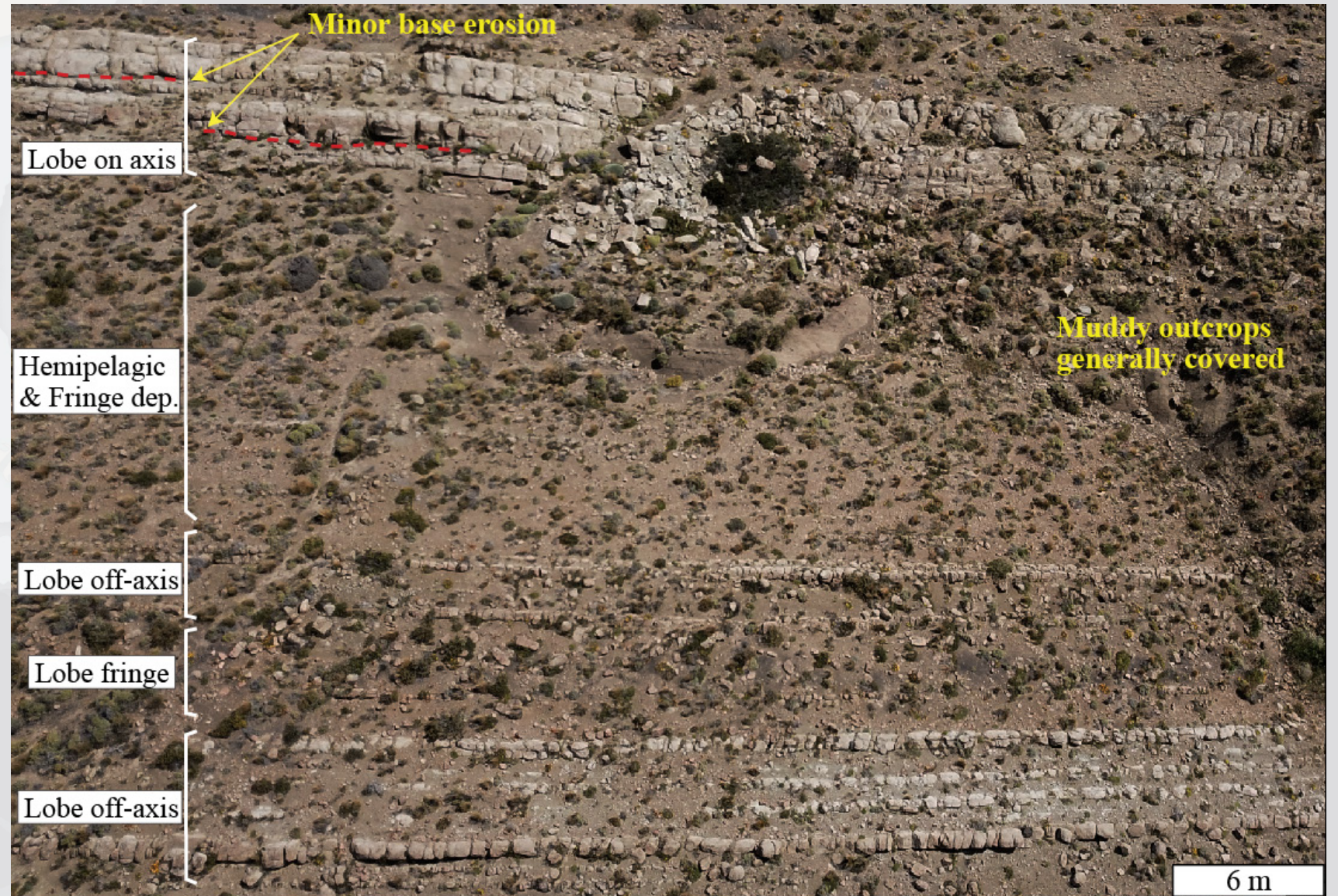
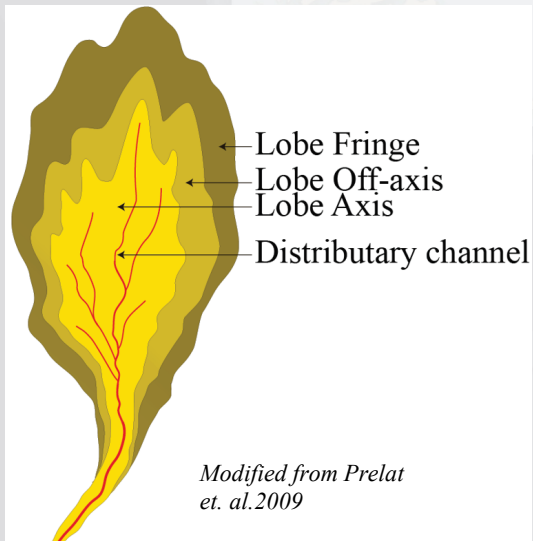


## High Density Turbidites



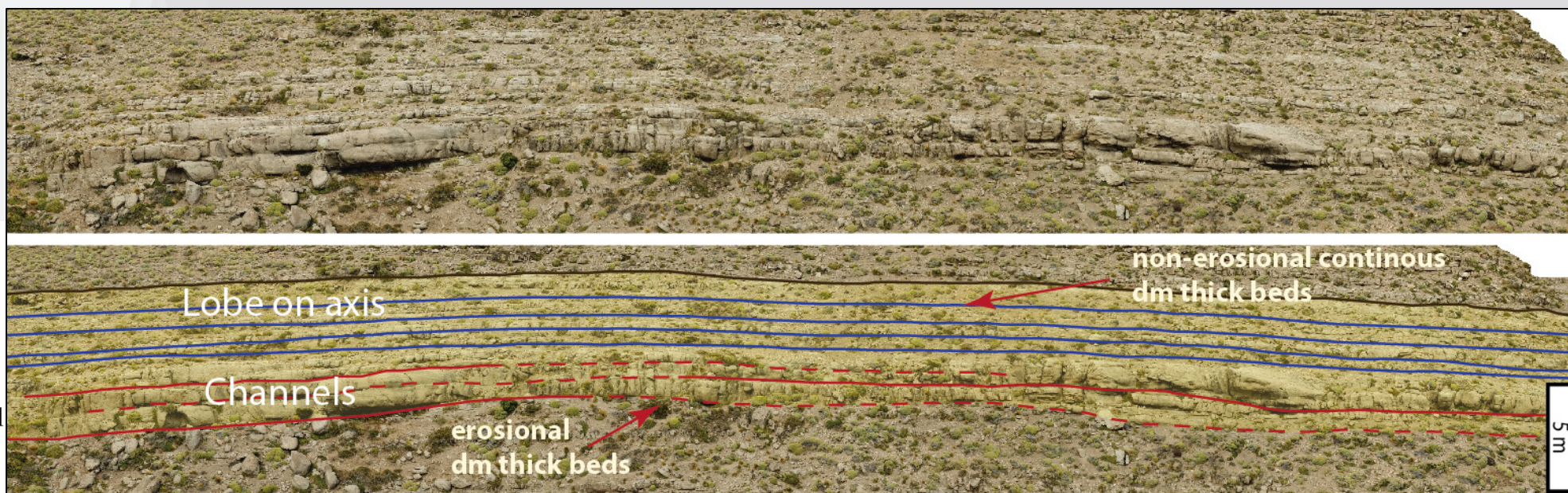
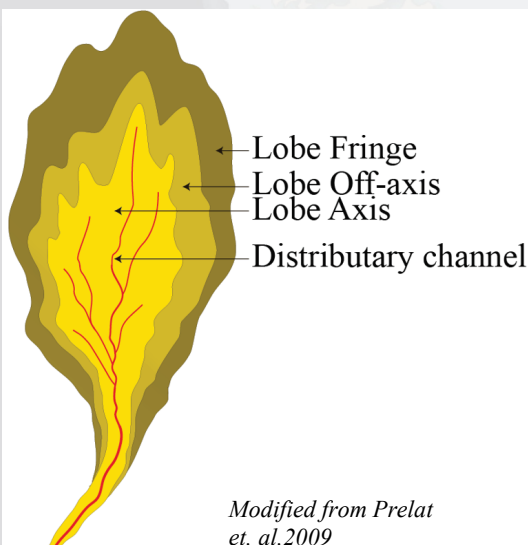


- Facies
- Geometries
- Degree of amalgamation



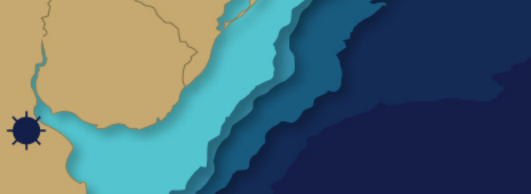
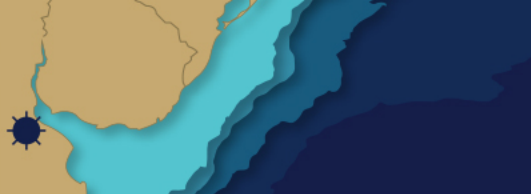


- Facies
- Geometries
- Degree of amalgamation

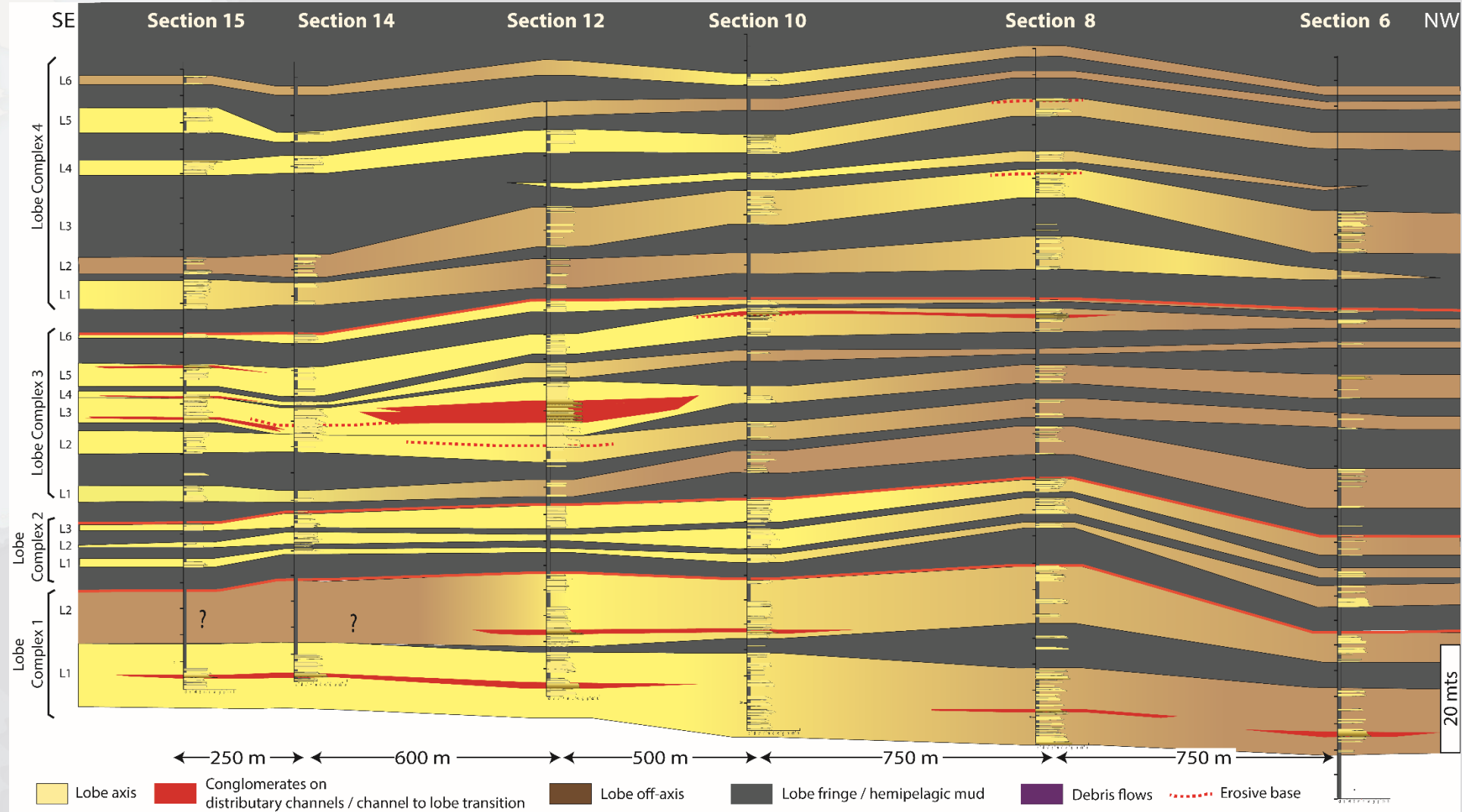
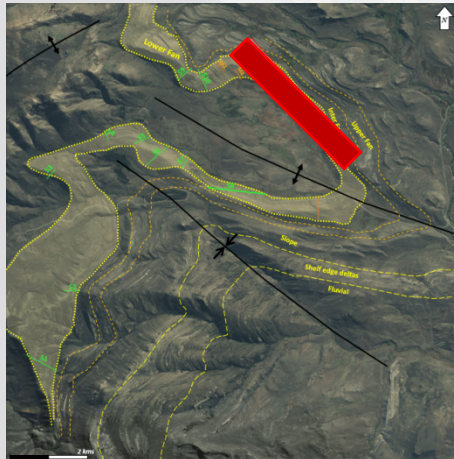




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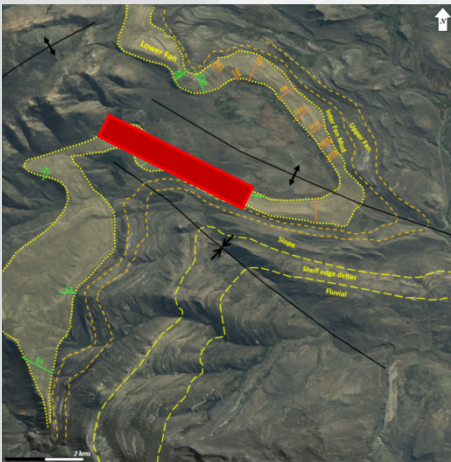
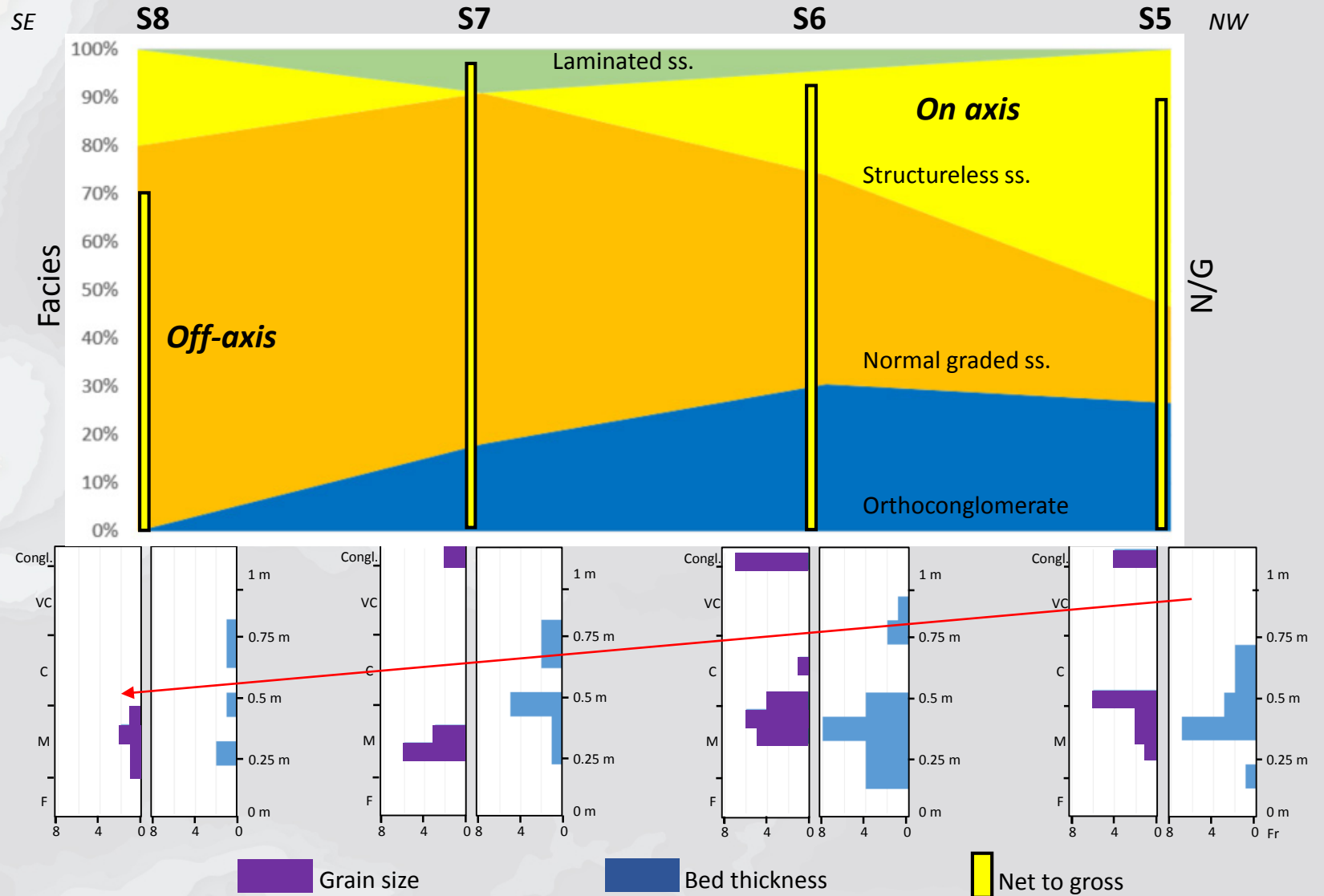


- 2.85 km panel, strike / oblique view
- Lower N/G (detail next slides)
- Stacking patterns not as clear as in panel 1.  
Mostly aggradational
- LC3 channels connect with panel 1



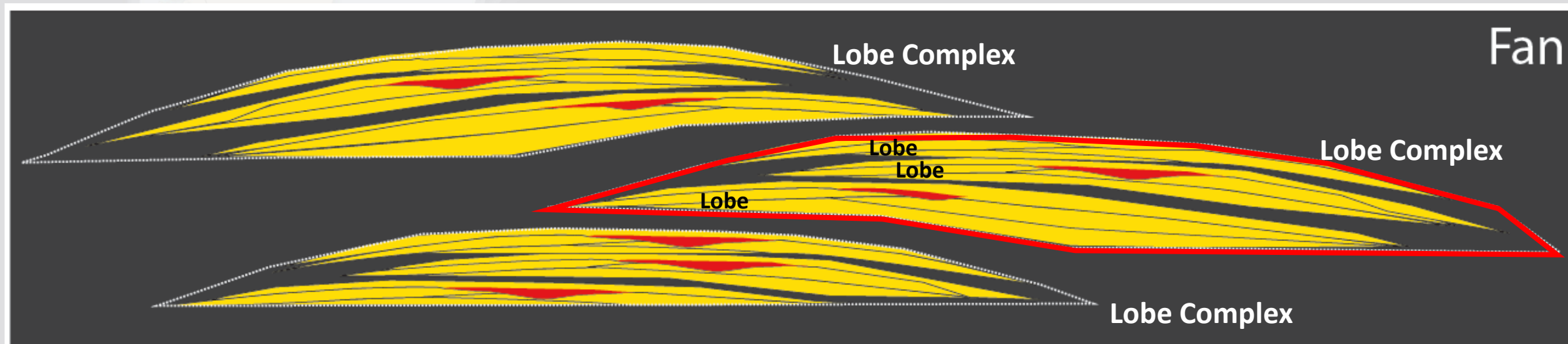
# Trends on Lobe Complex 3

- Facies variation from **High density** (conglomerates and structureless sandstone) to **low density** turbidites (normal graded sands and laminated sands)
- N/G decreases from 90% to 70%
- Grain size decreases towards SE. Coarse sandstones and conglomerates to Medium sandstone
- Bed thickness slightly decreases towards SE





## Hierarchical Division

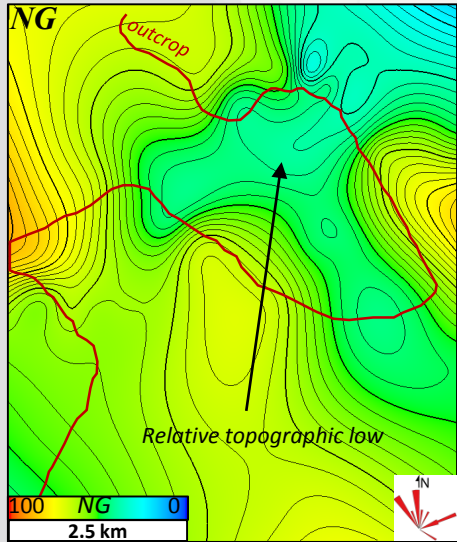


*Modified from Prelat et. al. 2009*

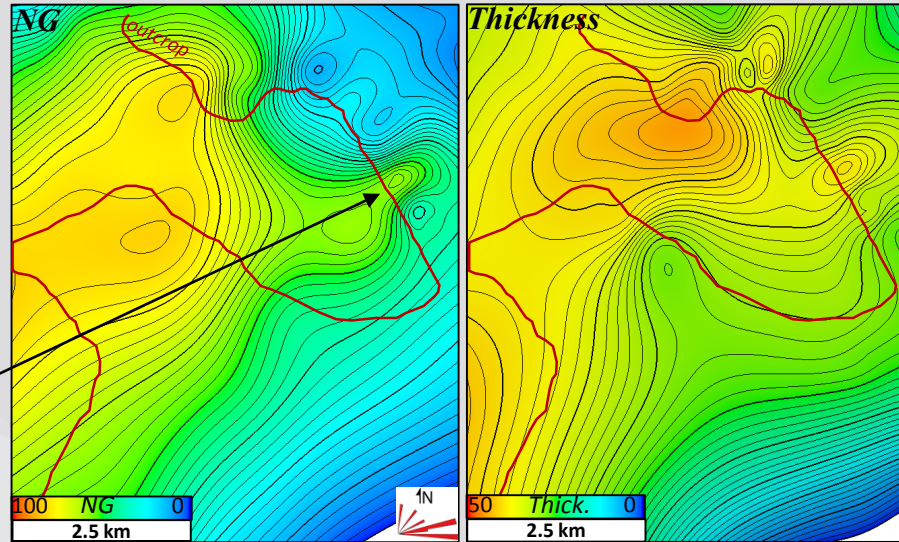


# Net to gross & thickness maps

LC1



LC3



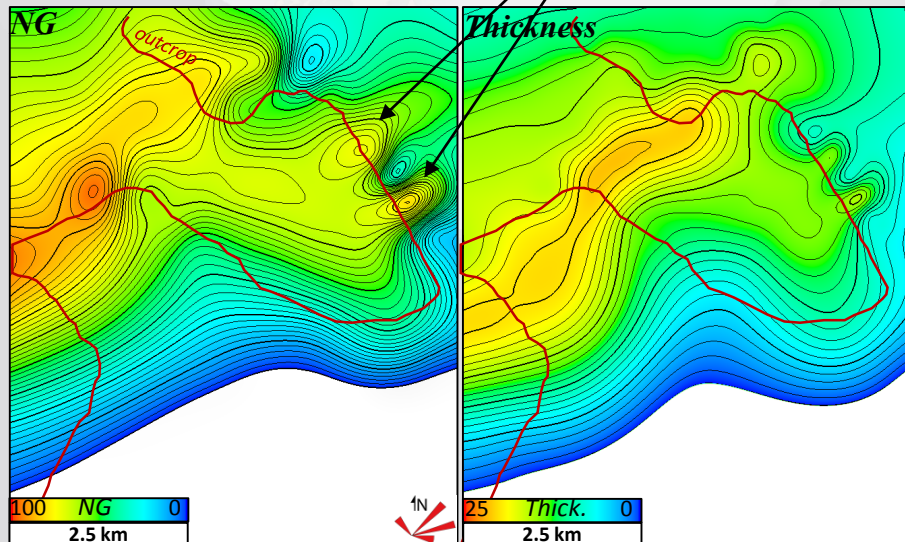
LC1

- Different paleocurrents reflected on N/G distribution

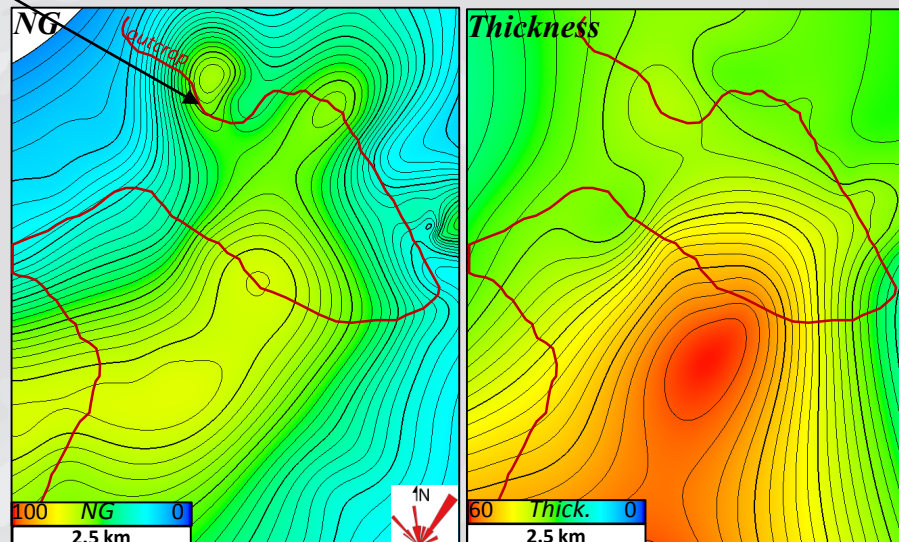
LC2

- Thickness and N/G with similar orientation as paleocurrents
- Finger-like geometry downdip
- Progradation and aggradation of LC3 over LC2

LC2



LC4



LC3

- Thickness and N/G with similar orientation as paleocurrents
- Backstepping and shifting to the southeast

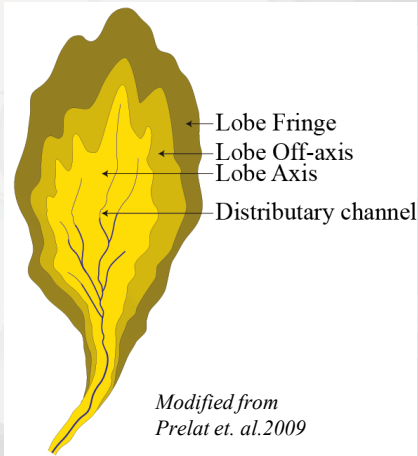
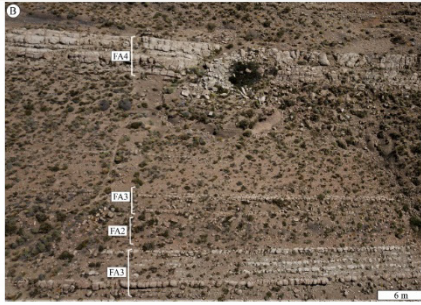
LC4

- Thickness and N/G with similar orientation as paleocurrents
- Finger-like geometry downdip
- Distributary channels controlling N/G and thickness

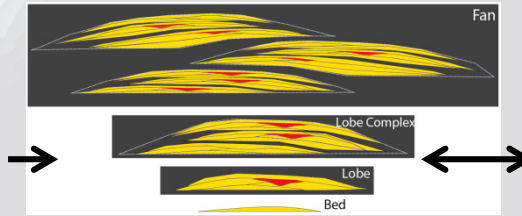
## Facies analysis



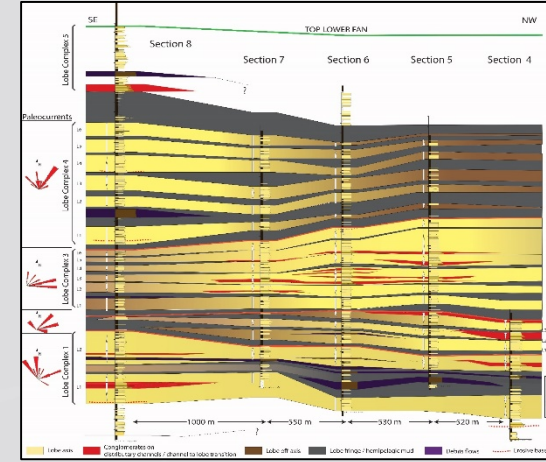
## Facies association



## Hierarchical Division



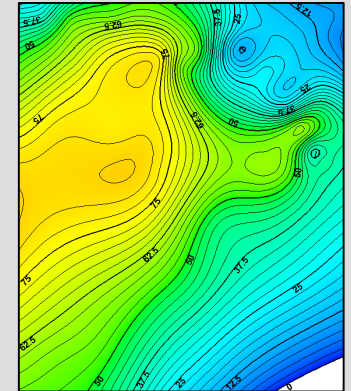
## Correlations



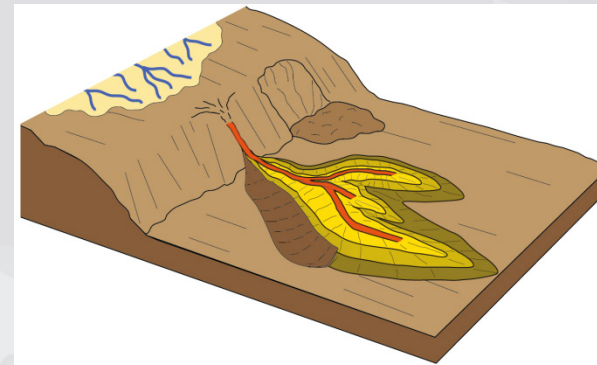
## Lobe's Trends



## N/G & Thickness maps

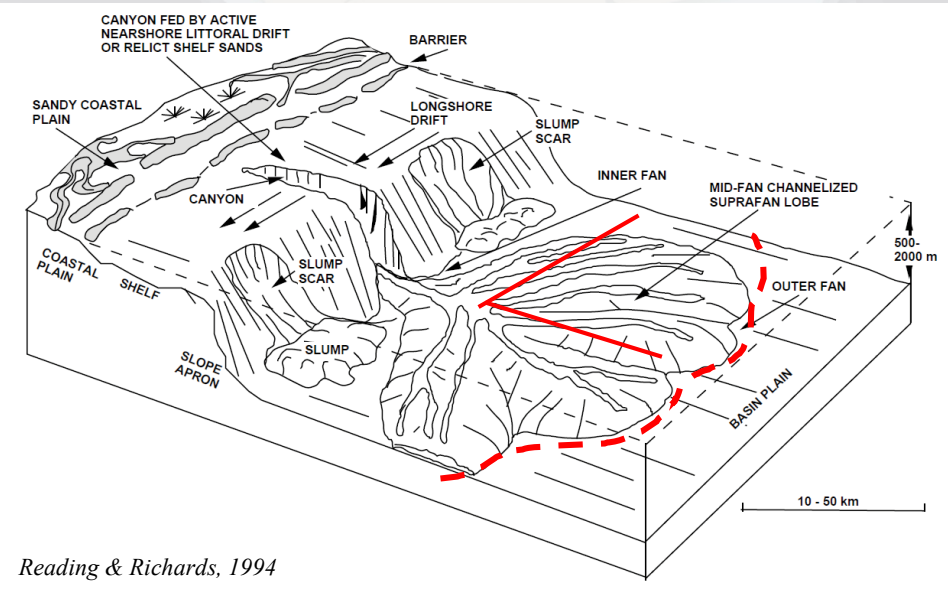


## Coarse-grained fan model





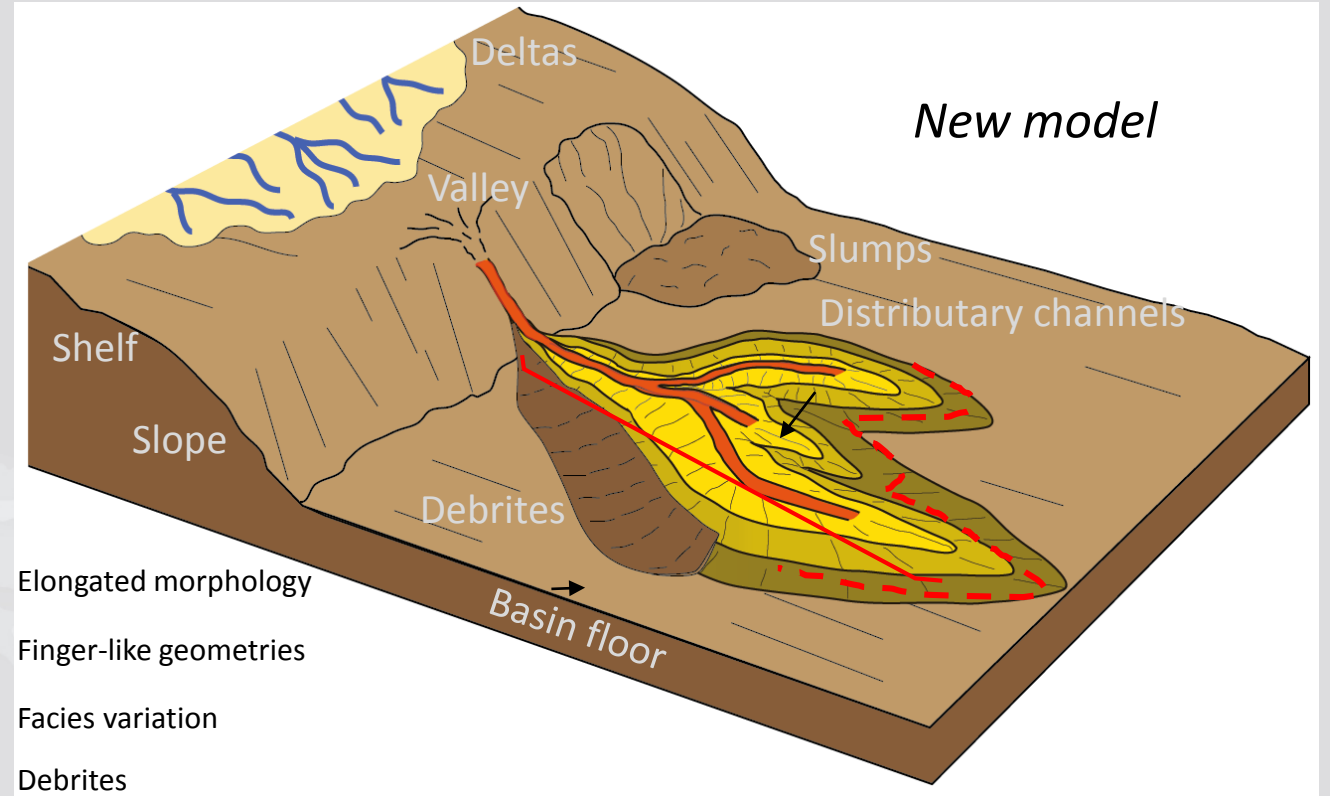
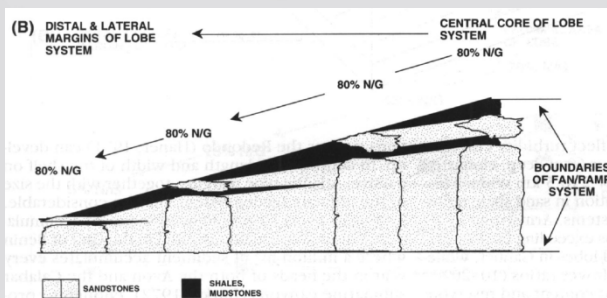
# Coarse-grained fan model



Radial morphology

Uniform sediment distribution downdip

NG differentiation only

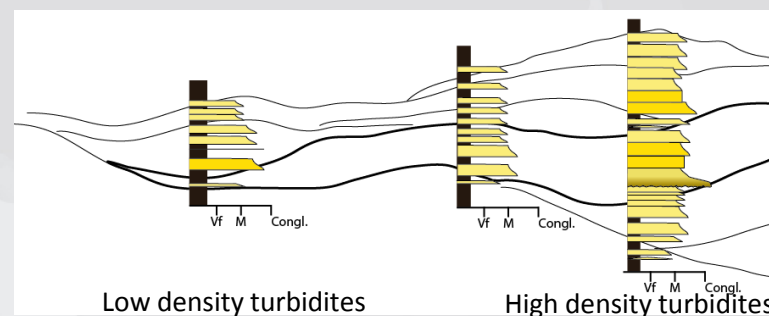


Elongated morphology

Finger-like geometries

Facies variation

Debrisites



- The basin floor fan being studied is composed of 5 lobe complexes (20 – 40 m thick). Each lobe complex is composed of 2 to 6 lobes (<10 m thick) that are mainly formed by continuous deposits (unconfined flows), although channelized features were identified throughout the succession
- The stacking patterns at a lobe complex scale are autocyclic responses due to compensational stacking. There is minor progradation / retrogradation of the system. Serrated geometries downdip are a response of focused sediment dispersal associated with channels and high density turbidites
- From the axis to the fringe of the lobe, channelized features diminish, facies and grain sizes show changes in the flow regime from high to low density turbidity flows
- The extensive outcrops of early-mid Jurassic Los Molles Fm. in Neuquén Basin present the chance to refine the model for coarse-grained deep-water fans