Static Fracture Distribution Model Based on Sedimentary Facies*

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Search and Discovery Article #41959 (2016)**
Posted December 5, 2016

*Adapted from oral presentation given at AAPG 2016 International Convention and Exhibition, Cancun, Mexico, September 6-9, 2016

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Abstract

Fluid flow modeling of highly heterogeneous reservoirs, both, siliciclastic (SR) and naturally fractured (NFR), requires stratigraphic and facies architecture characterization, fracture systems identification, and zonation of petrophysical parameters. Fracture systems in reservoir modeling are usually represented as lines or planes, giving inaccurate values of petrophysical parameters, disconnecting the dynamic conceptual model from its geological controls. An alternative to characterize fracture systems, taking in account their 3D attributes, is to explore the correlation between sedimentary facies distribution and the probability distribution of fracture systems, giving rise to the fracture facies characterization. In this work, we show the static characterization of a SR analogue using outcrop data to investigate the stratigraphic architecture control over fluid flow using the probability distributions of fractures systems for each sedimentary facies association proposed. Fracture facies technique provide an independent scalar statistical framework to characterize the spatial heterogeneity of a sedimentary deposits, allowing to identify, and to quantify, rock volumes with parameters statistically similar without oversimplifying SR and NFRs heterogeneities. Sedimentological and structural descriptions were performed on outcrops and drilling cores recovered from siliciclastic intervals of the Chicontepec Fm., sedimentary facies were logged and grouped to form facies associations, which were then complemented with their respective intensity distributions of fracture systems. The intensity distribution of fractures was obtained with curves of cumulative fracture intensity (CFI), which allowed determining the type of correlation (positive or negative) between the distribution of fractures and the facies, which contain them. The CFI curves allow essaying models for the distribution of fractures as a function of different sedimentary facies associations. We conclude that CFI curves are useful to identify areas with different fracture intensity values (mechanical layers), which adds to characterize the geological/petrophysical model of highly heterogeneous reservoirs.

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INSTITUTO MEXICANO DEL PETRÓLEO

THEME 6: NATURAL FRACTURE CHARACTERIZATION FOR UNCONVENTIONAL RESERVOIRS

Static Fracture Distribution Model Based on Sedimentary Facies

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Background & Objectives

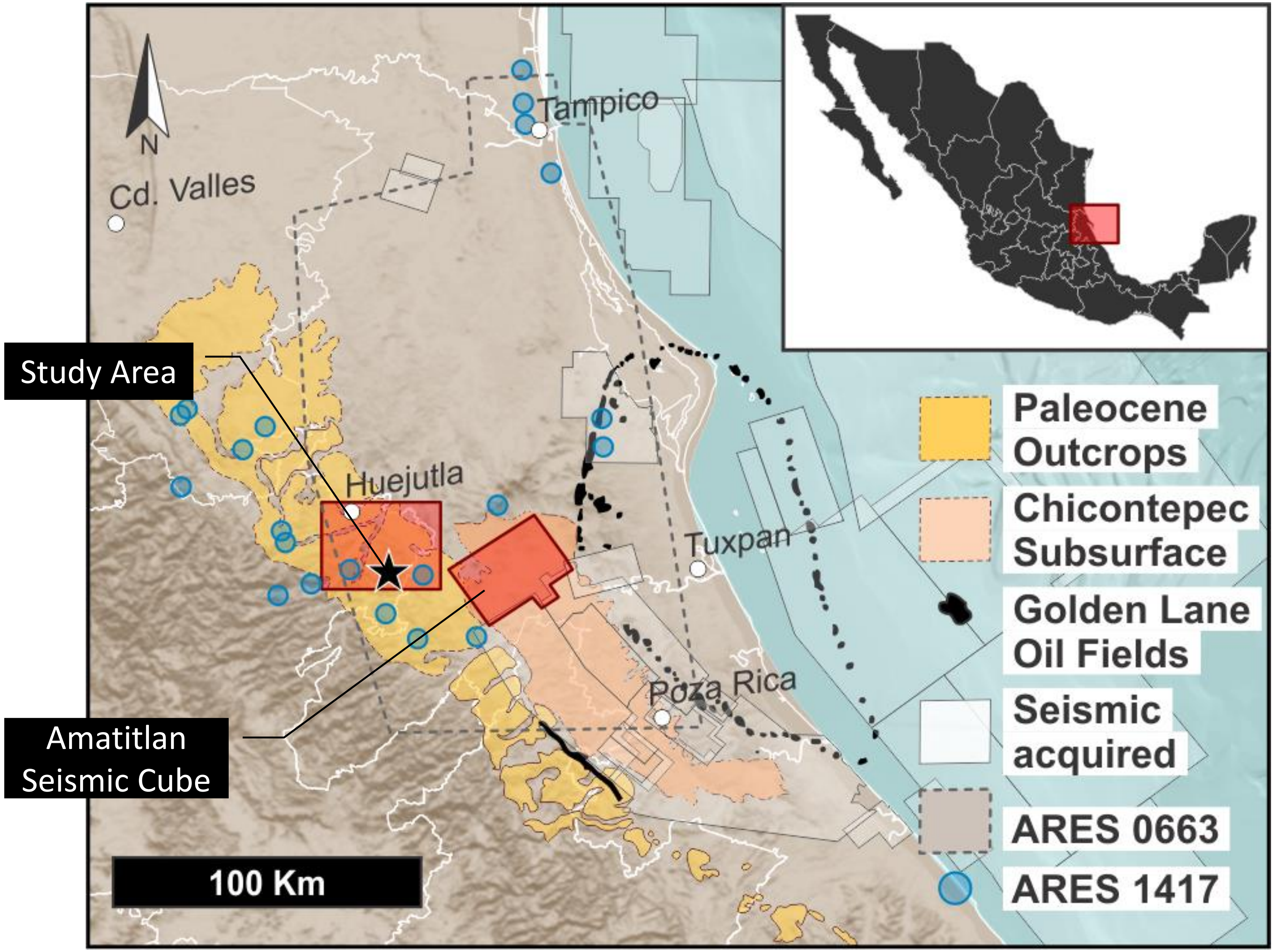
Background

- We show the **characterization** of a **siliciclastic reservoir analogue** using **outcrop data** in order to determine the type and degree of correlation between **sedimentary facies distribution** and the **probability distribution of fracture systems.**
- **Fracture facies technique provides an independent scalar statistical framework** to characterize the spatial heterogeneity of geobodies, without oversimplifying the reservoir heterogeneities.

Objectives

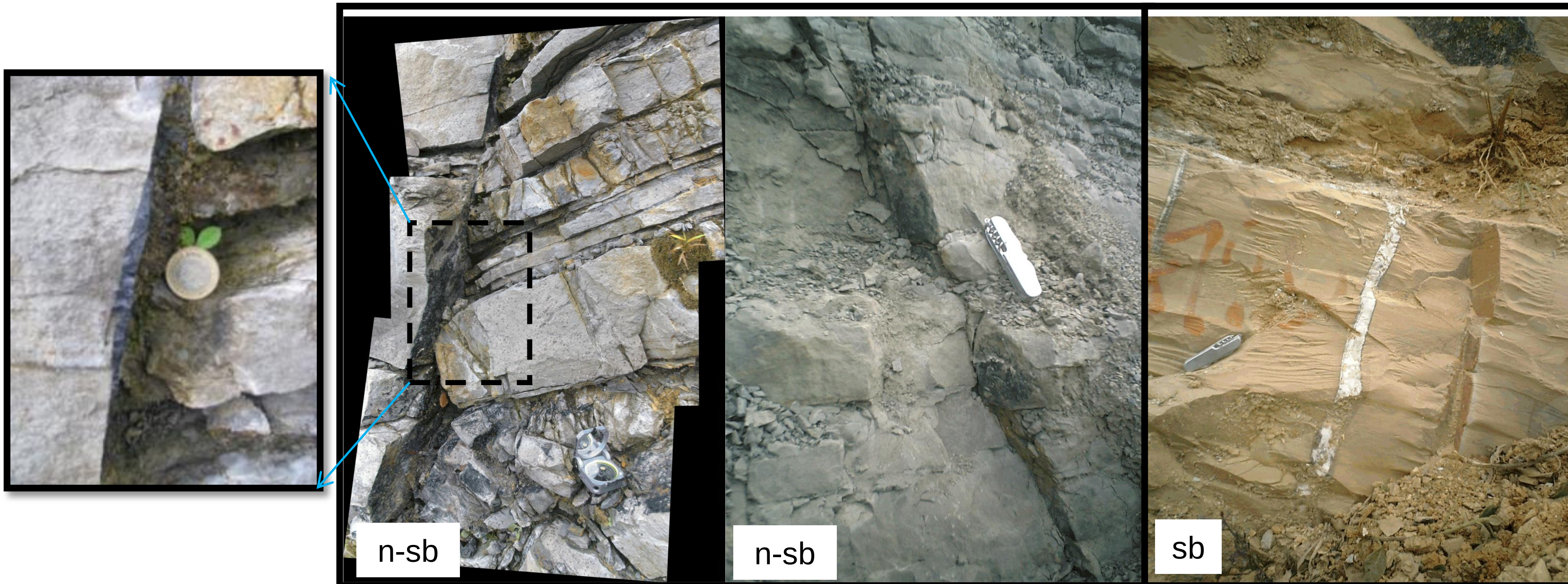
- To show the implemented methodology in the **static characterization** fractures and sedimentary facies in a **siliciclastic reservoir analogue**.
- Establish the **correlation** between sedimentary facies distribution and the probability distribution of fracture systems, giving rise to the **fracture facies concept**.

Location

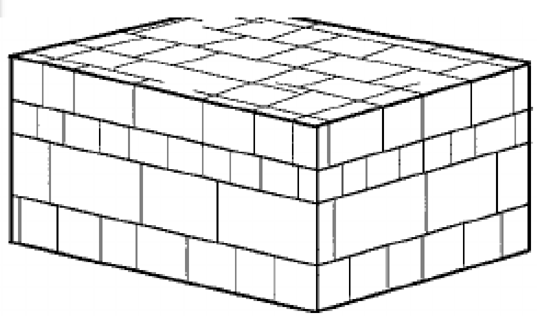


INEGI/CNH
Bitter, 1993

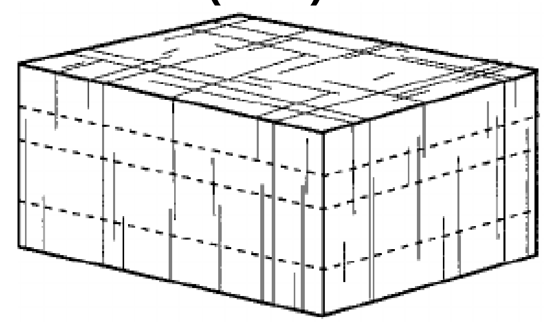
Fracture characterization



Strata bound fractures (sb)



Non-strata bound fractures (n-sb)



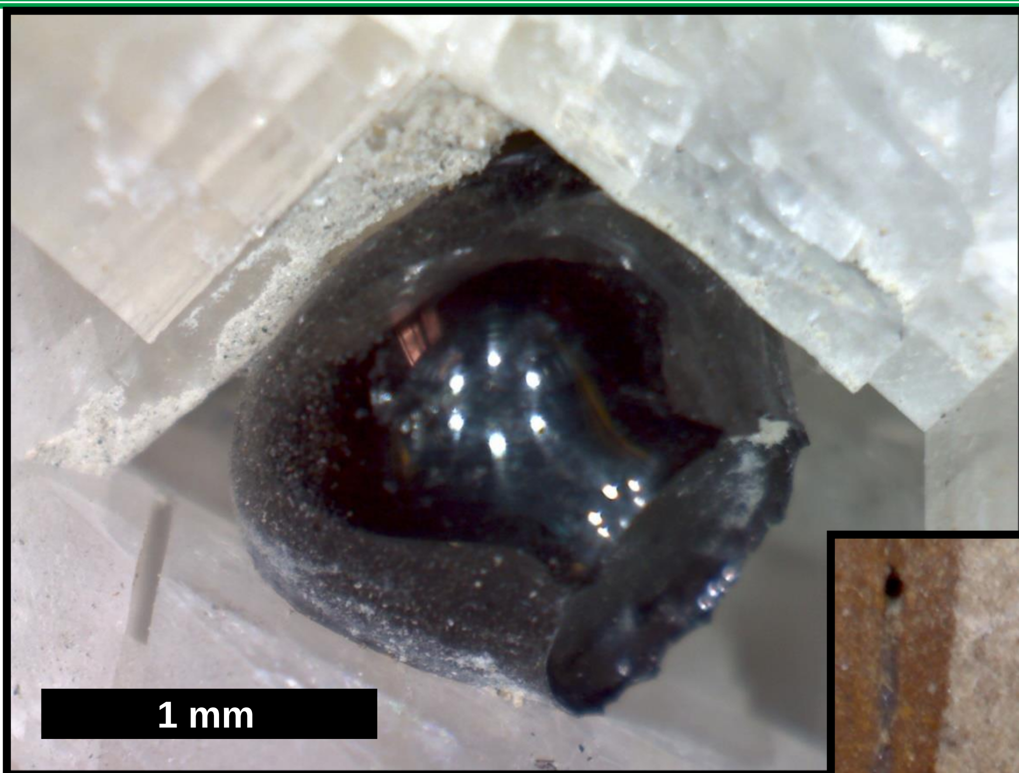
Odling *et. al*, 1999

Field evidences of oil bearing fractures in Chicontepec Fm.

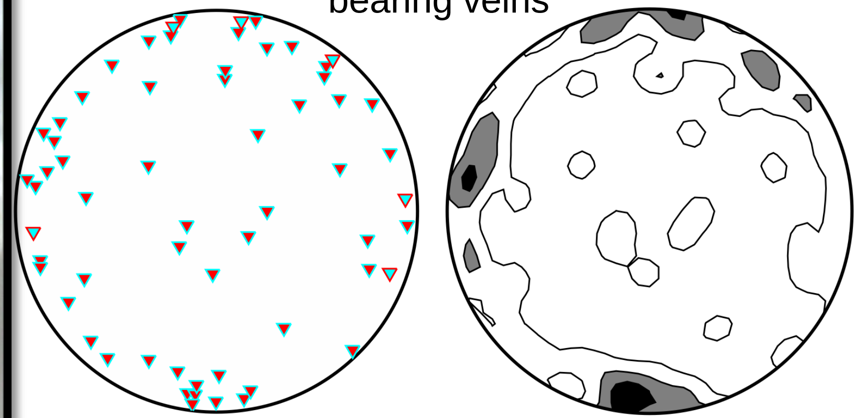
- Sandstone-shale sucession

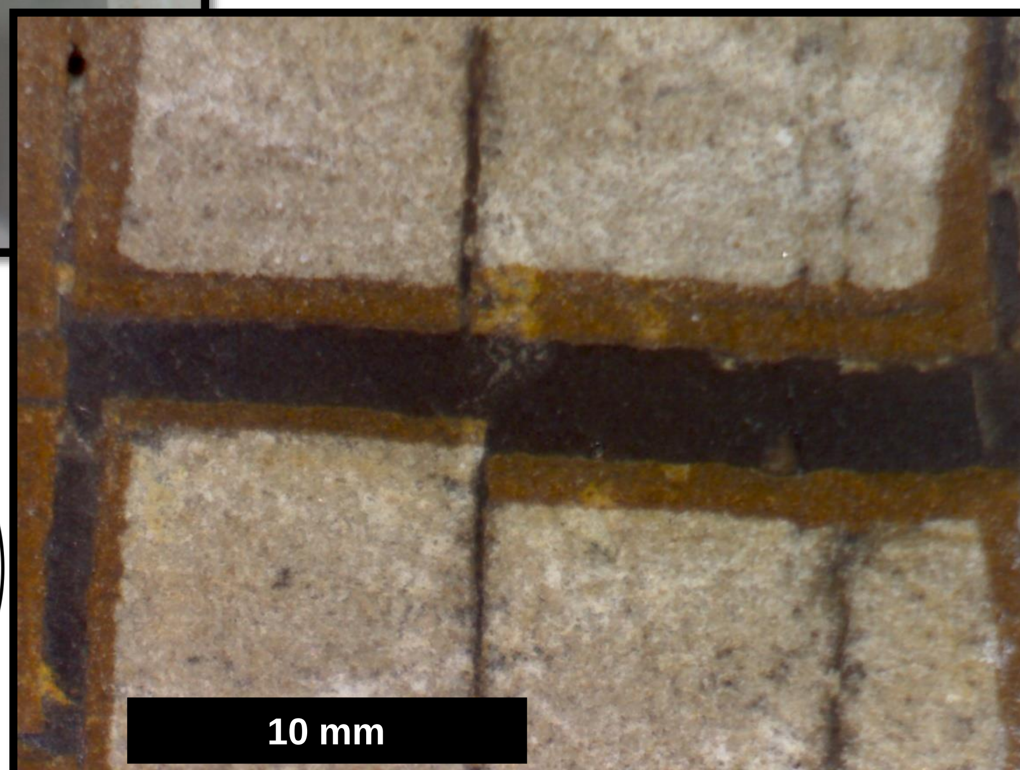
- Hc trough cross lamination, bed interfaces and fractures (N-S oriented system in this example)

Fluid flow through (micro) fractures

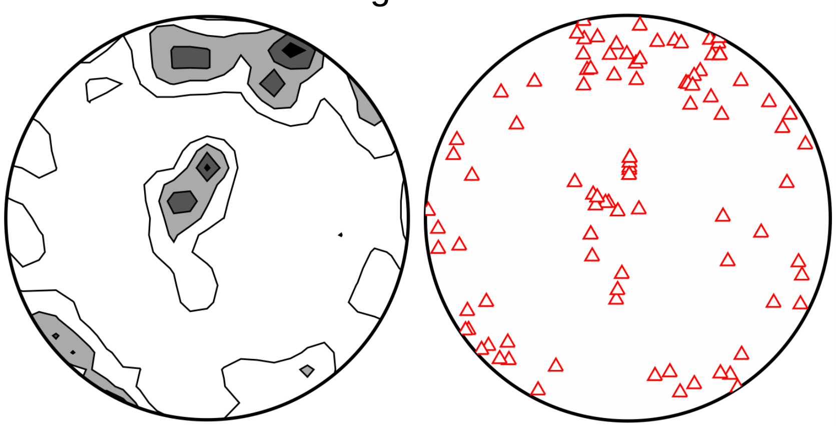


Equal-area plot and Schmidt plot of poles to oil bearing veins

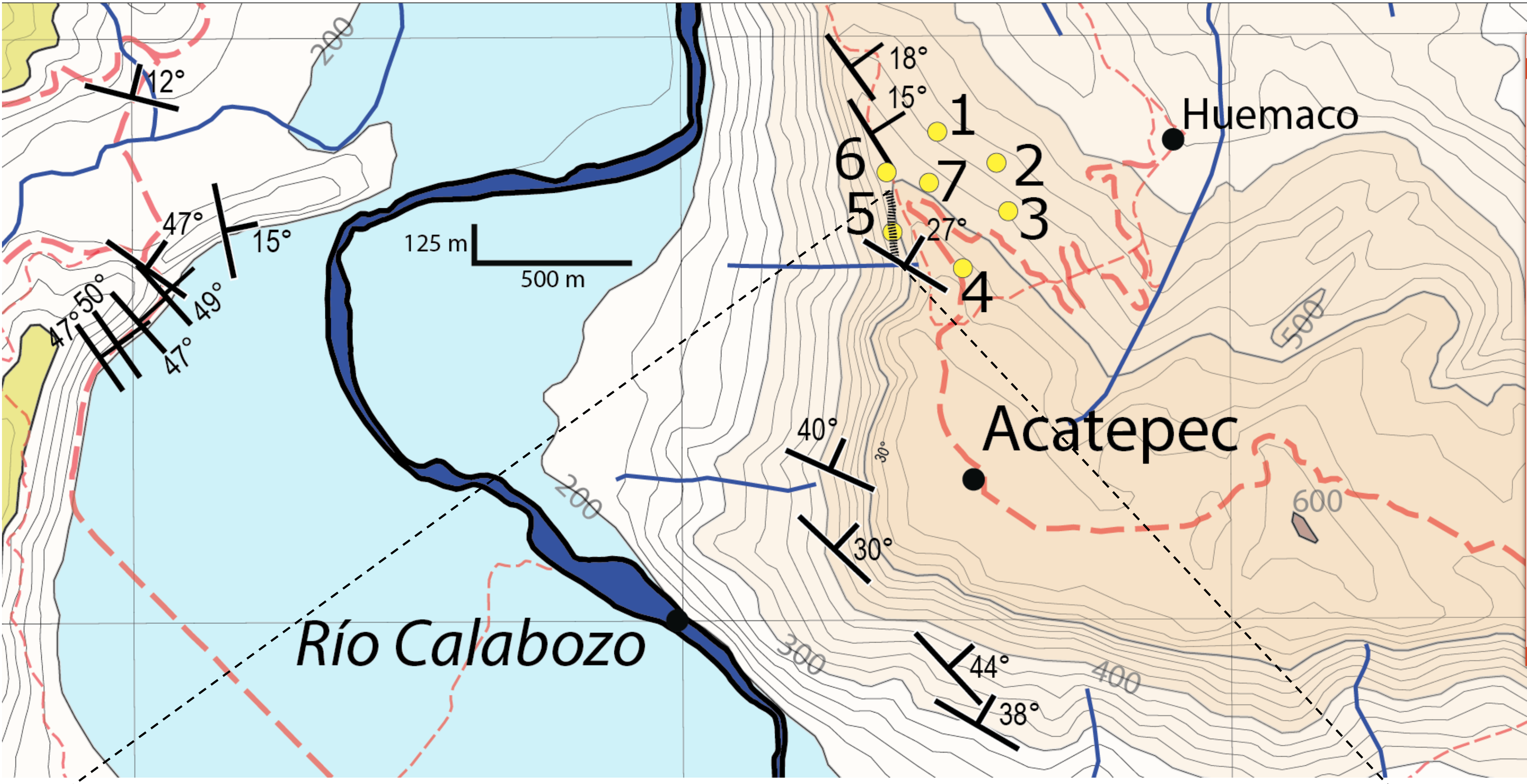


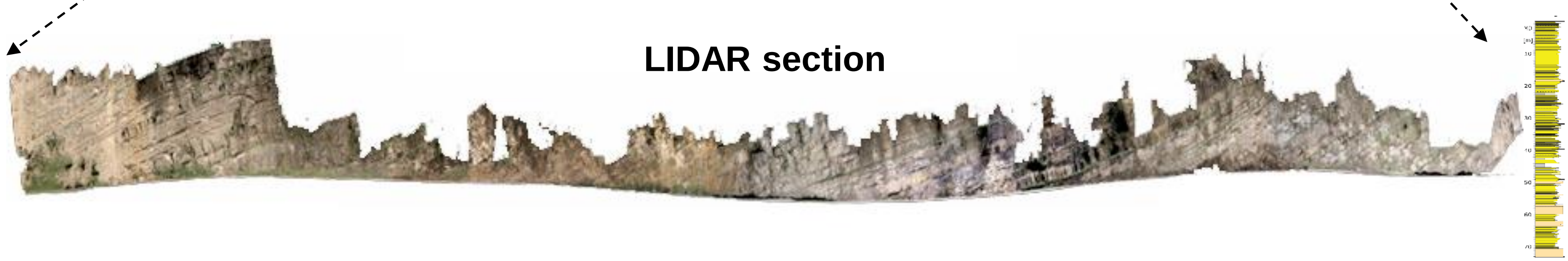


Equal-area plot and Schmidt plot of poles to oil bearing fractures



Local Geological Framework

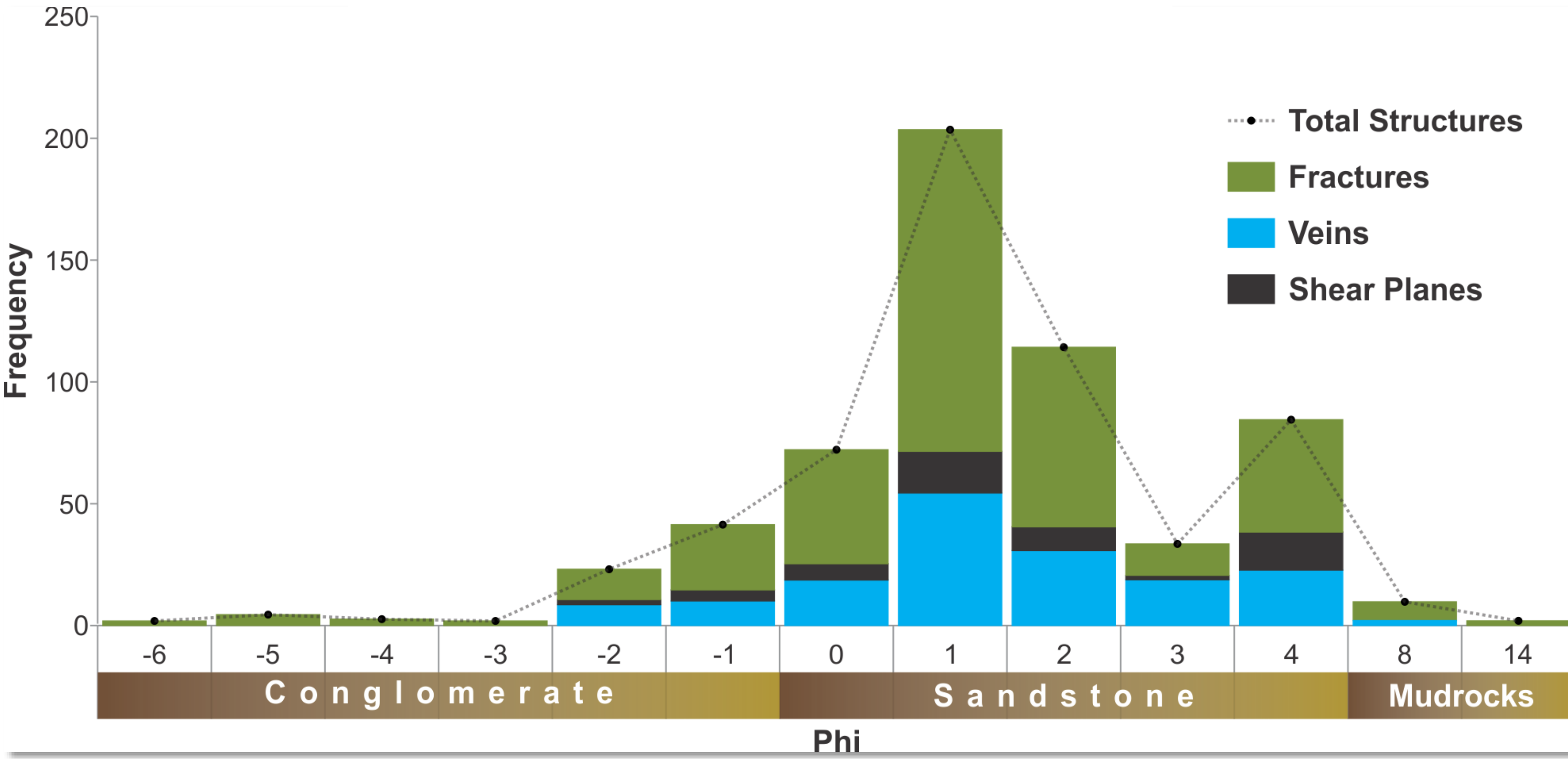




Sedimentary Characterization

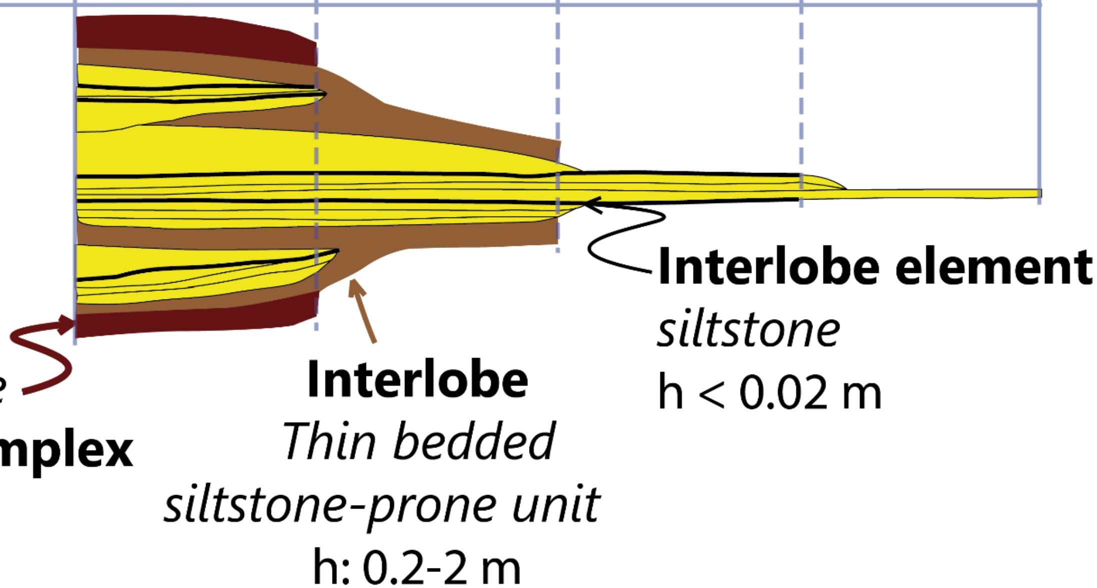
- Hc occurrence in primary structures and mainly in sandstone facies

Structure frequency vs granulometry



Lobe-complex hierarchy

	Lobe complex	Lobe	Lobe element	Bed
long	40 km	27 km	5 km	100s m
wide	30 km	13 km	3.5 km	
thickness [h]	30 - 60 m	4 - 10 m	1 - 3 m	~ 0.5 m
# of beds		1 - 10	1 - 6	1

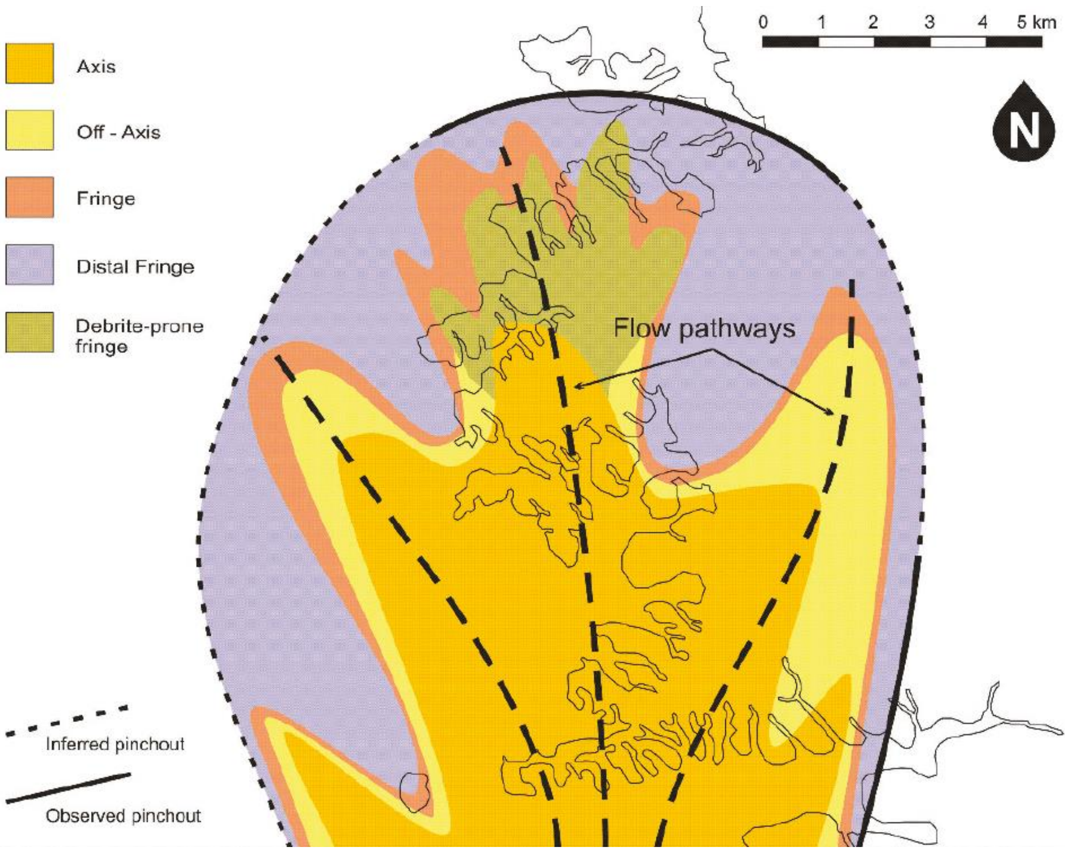


modified from Prélat et al., 2009

Depositional elements disposition (lobe system)

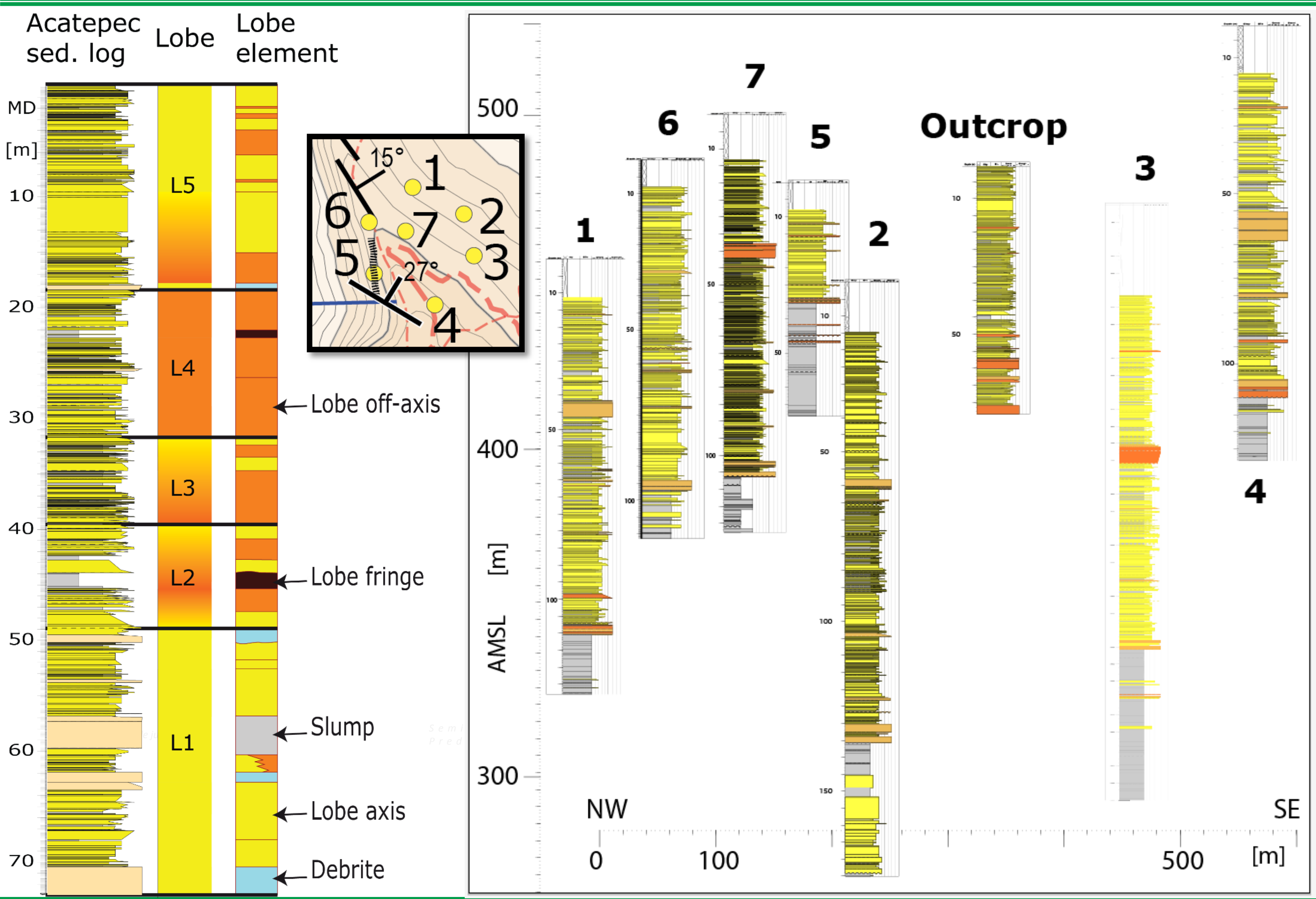
Lobe elements

	(Ap)	proximal	lobe axis
	(Am)	medial	lobe axis
	(Ad)	distal	lobe axis
	(OAp)	proximal	lobe off-axis
	(OAm)	medial	lobe off-axis
	(OAd)	distal	lobe off-axis
	(Fp)		lobe fringe
	Debrite		

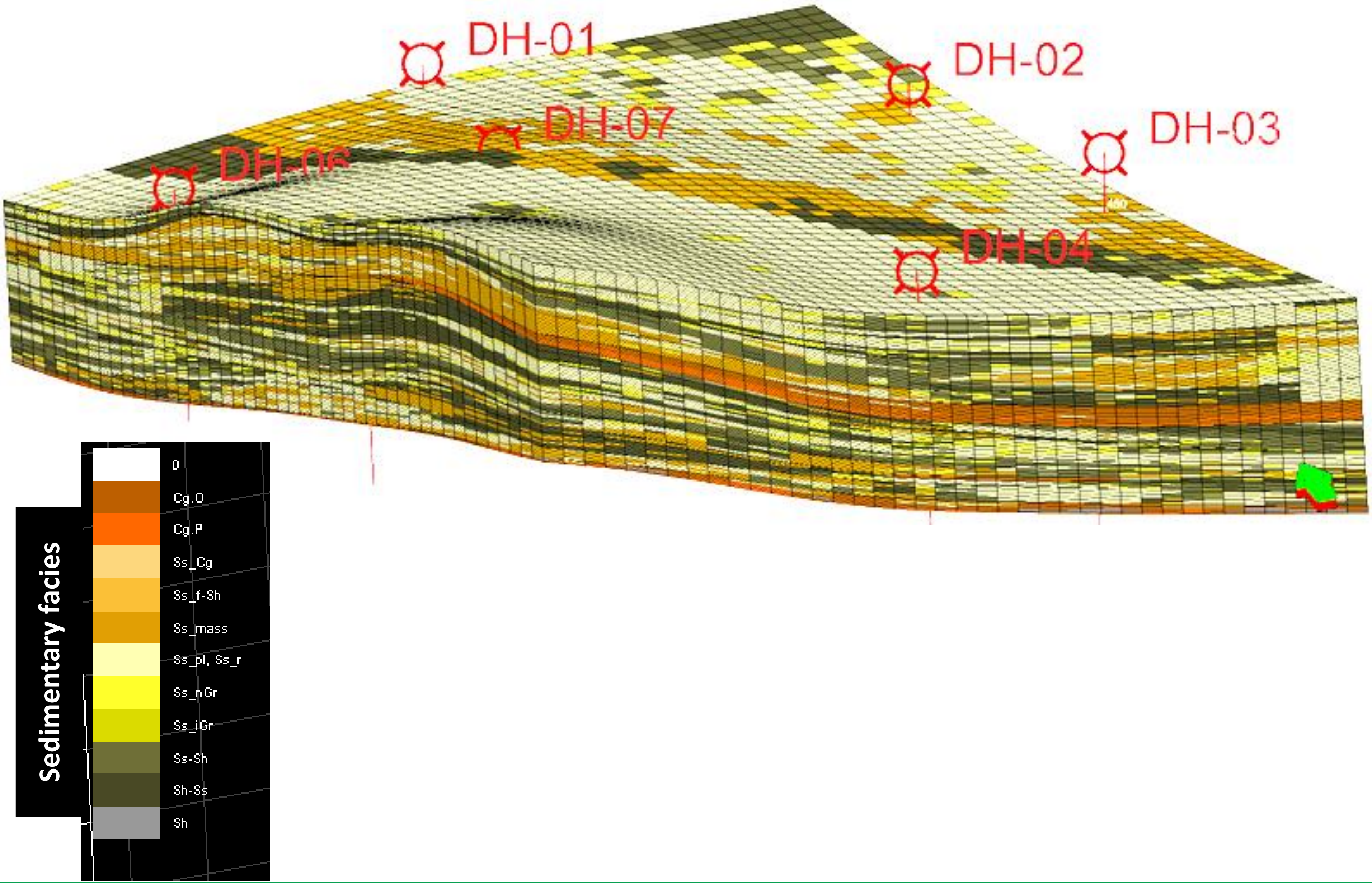


Groenenberg et al., 2010

Sedimentary logs (outcrop and 7 drills)

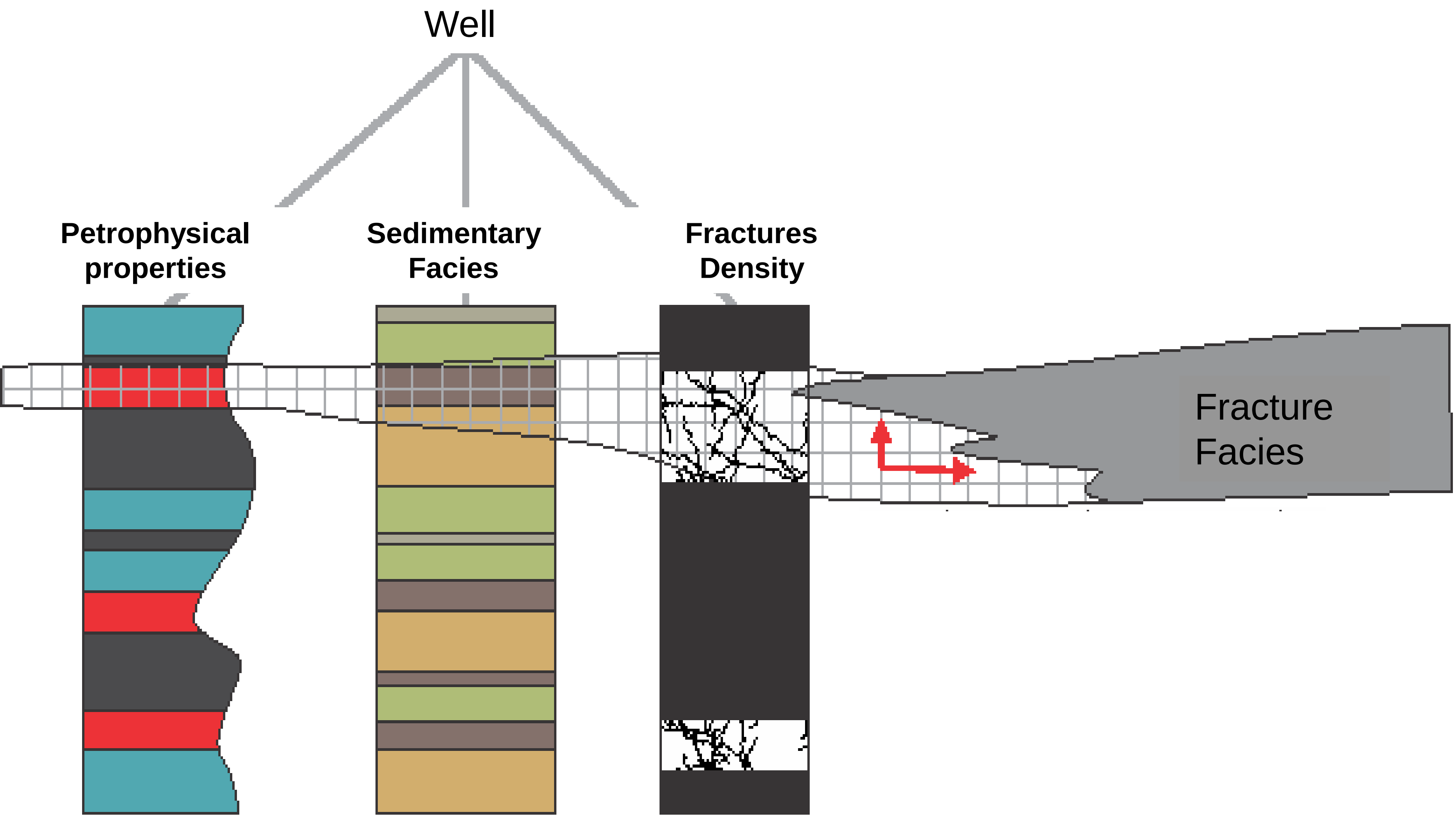


Geostatistical model with facies distributed

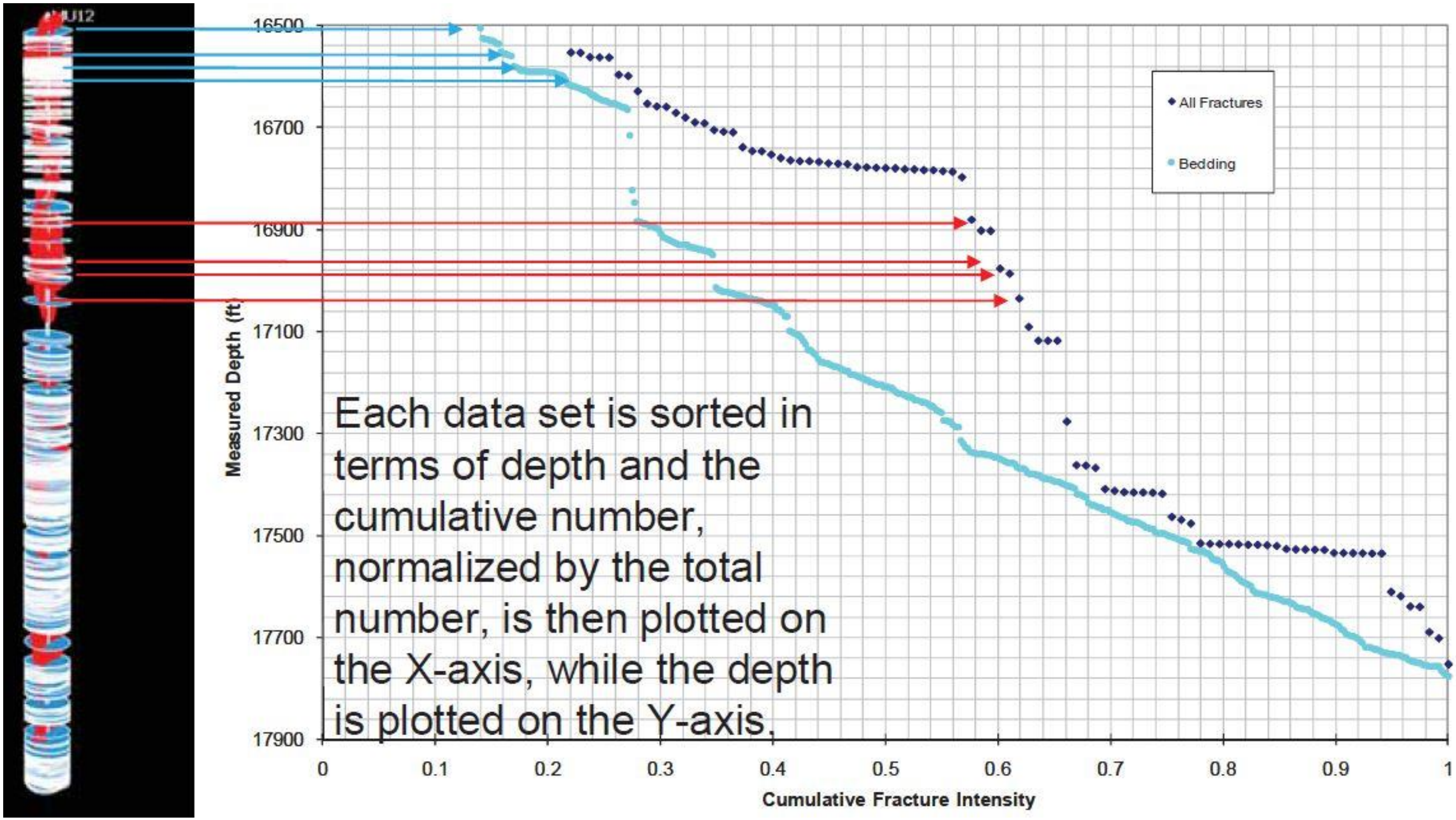


Fractures+Facies: Fracture facies

Fracture Facies: Defined by the relationship between the occurrence of structural discontinuities (fracture density) and facies distribution .

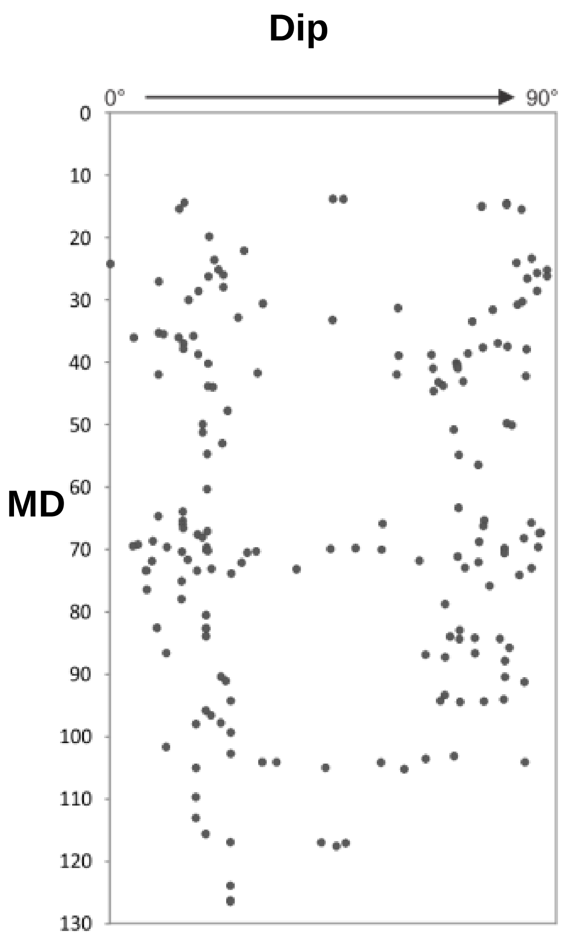


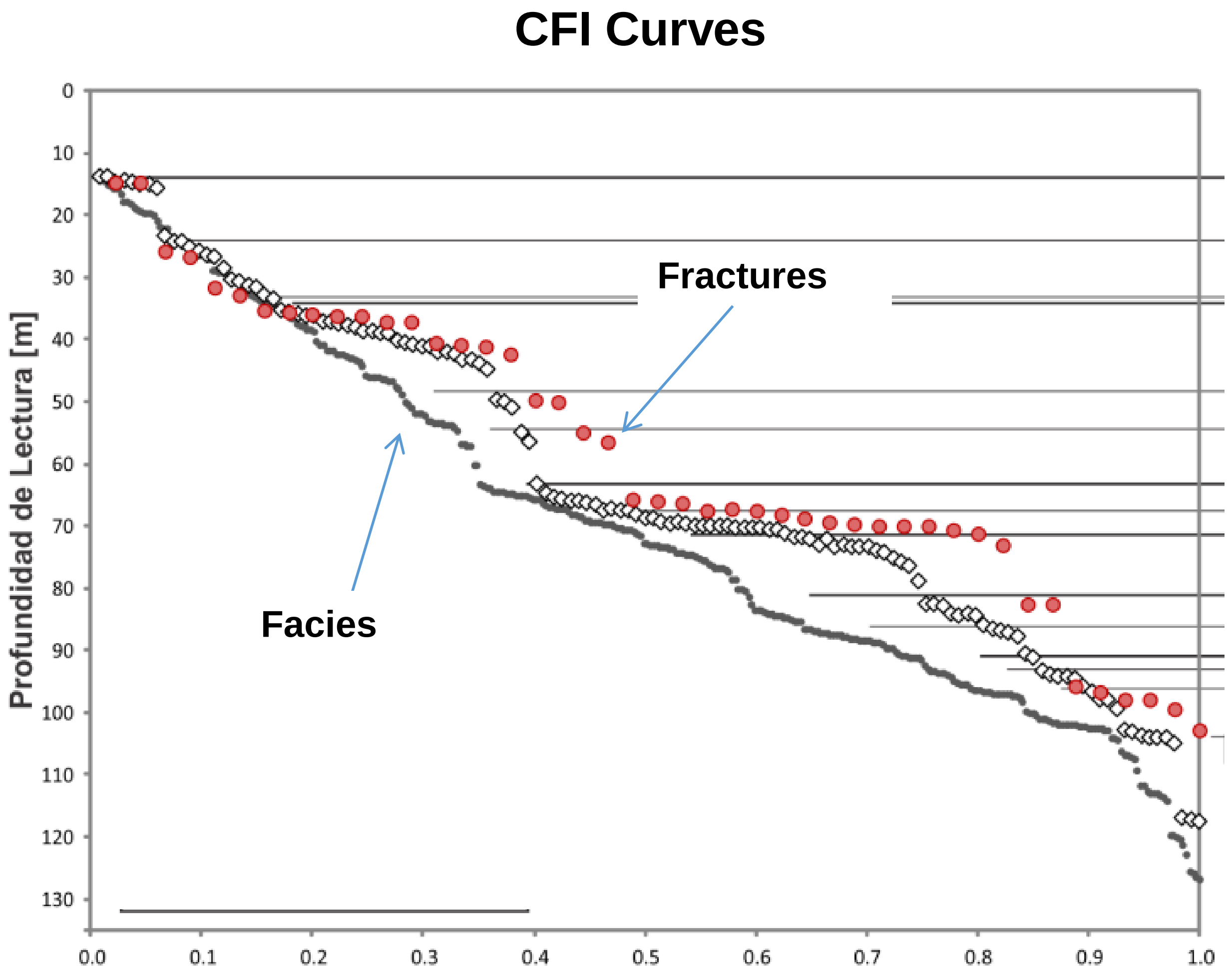
Cumulative Fracture Intensity Curves



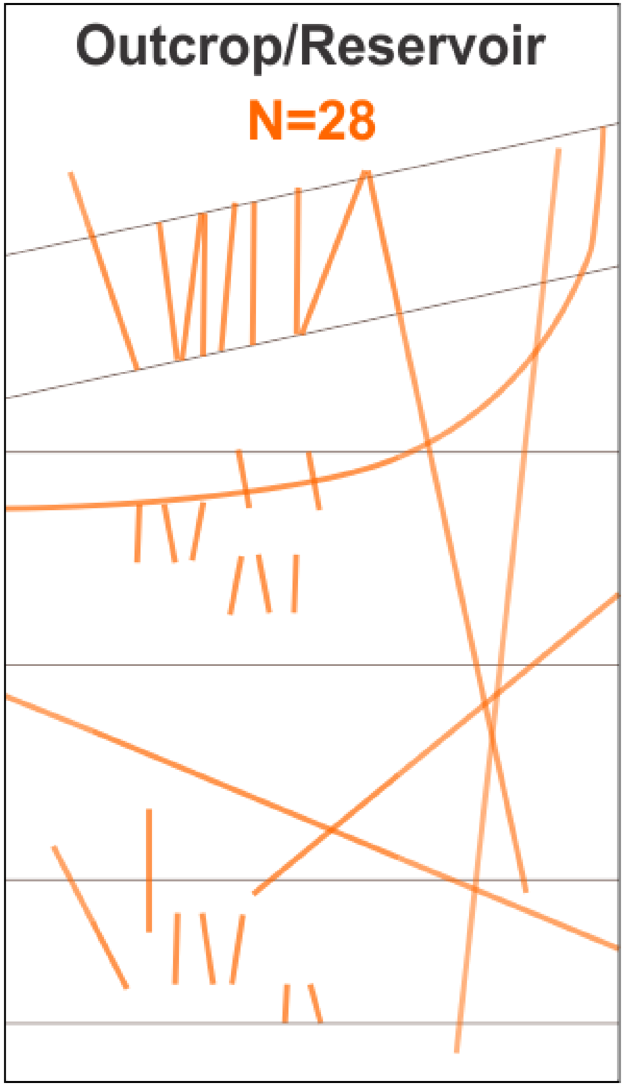
La Pointe, 2010

Dip register





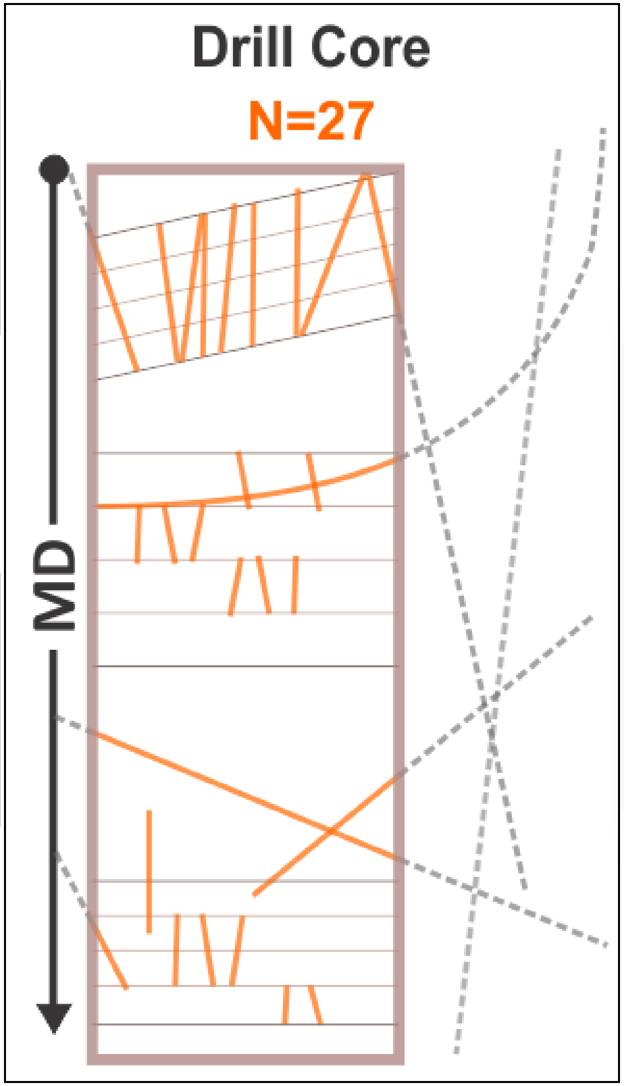
Fracture & Facies Characterization

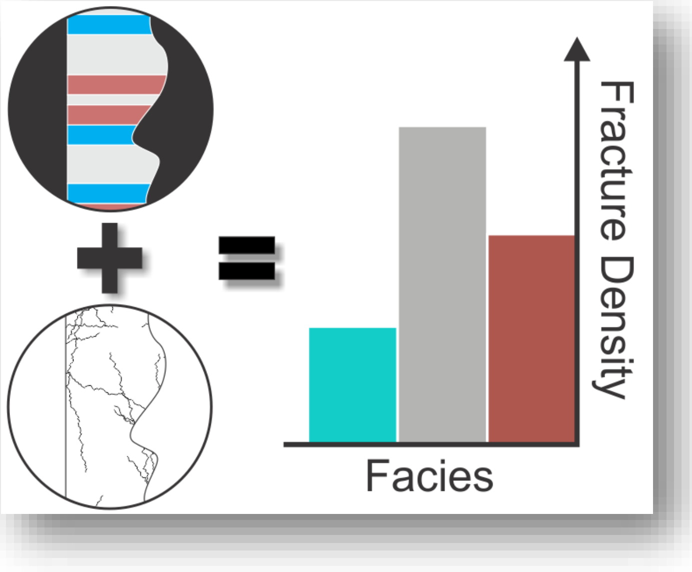


Fracture & Facies Characterization

Sampling bias:
Number of geologic features depends on sampling window size.

- Fracture population size reduced
- More detailed description of facies





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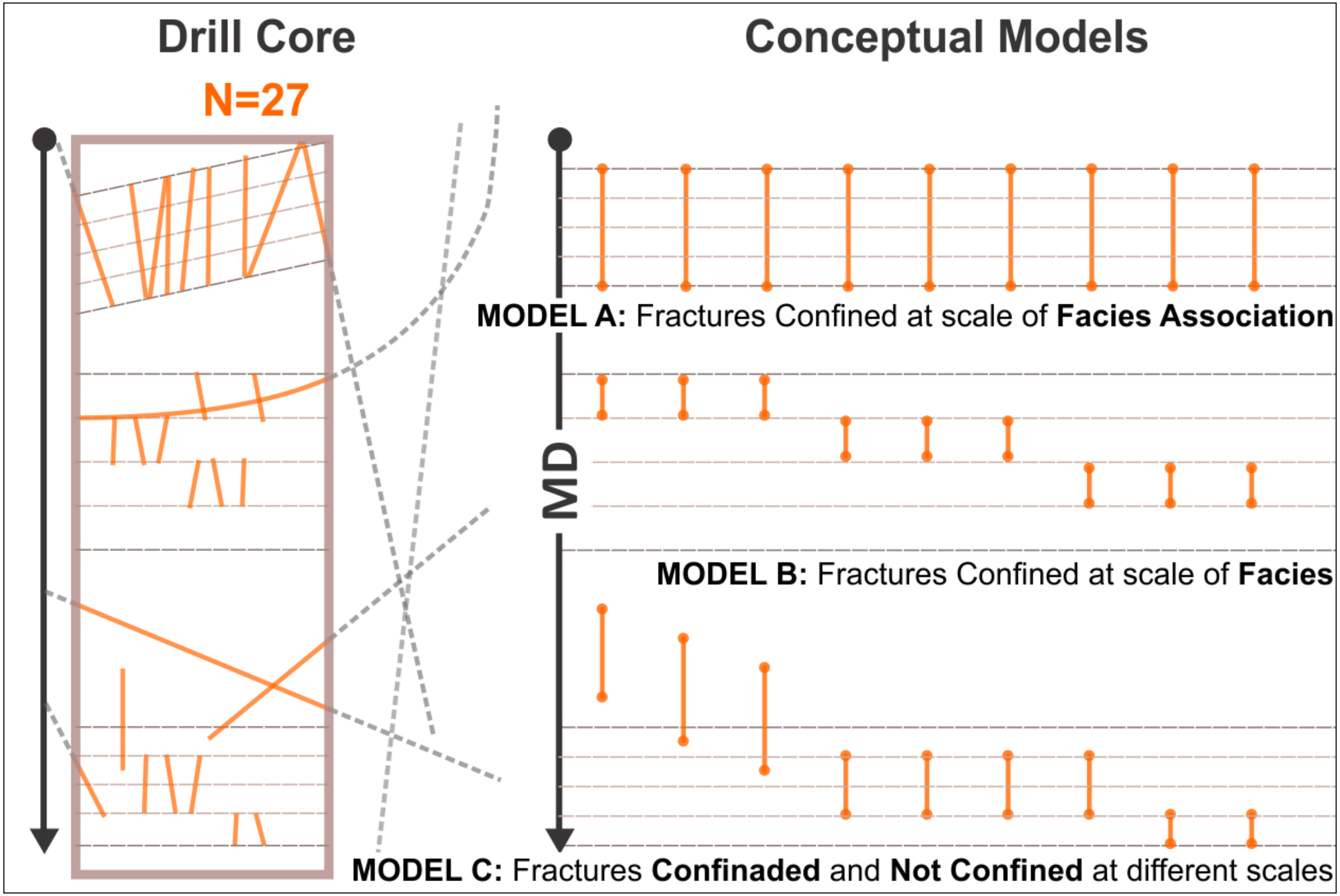
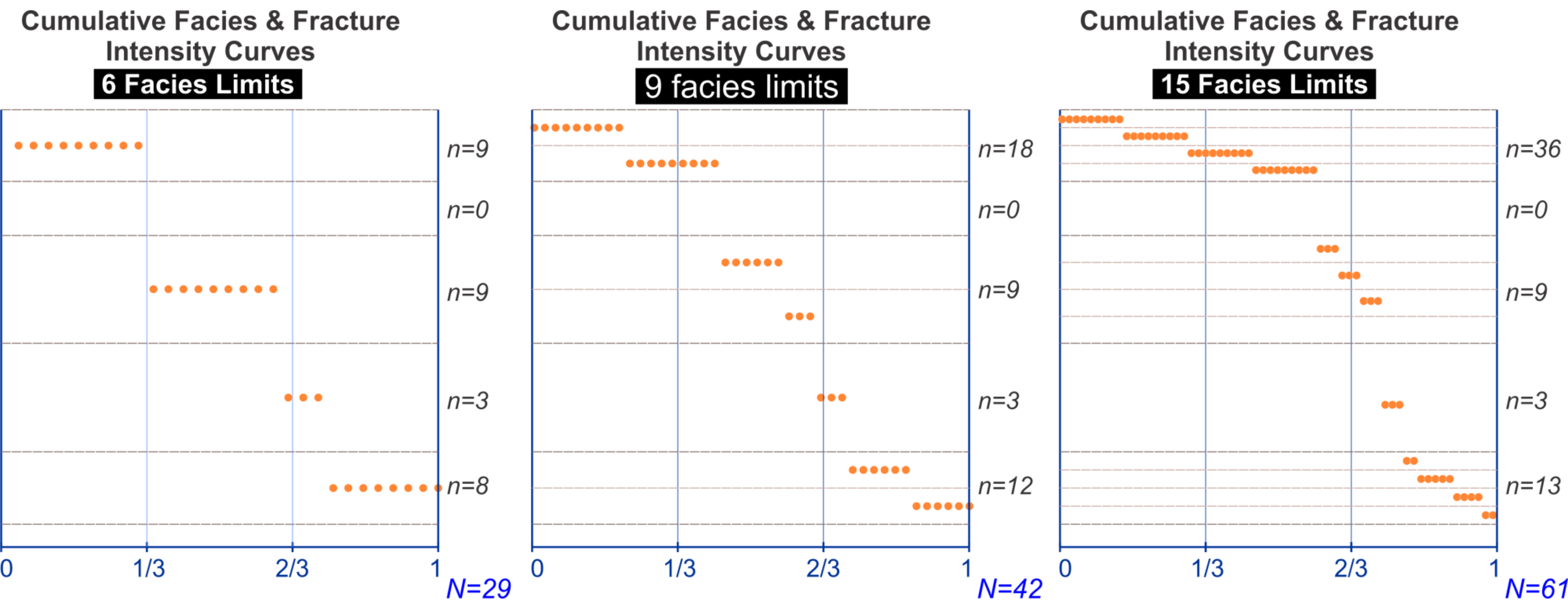
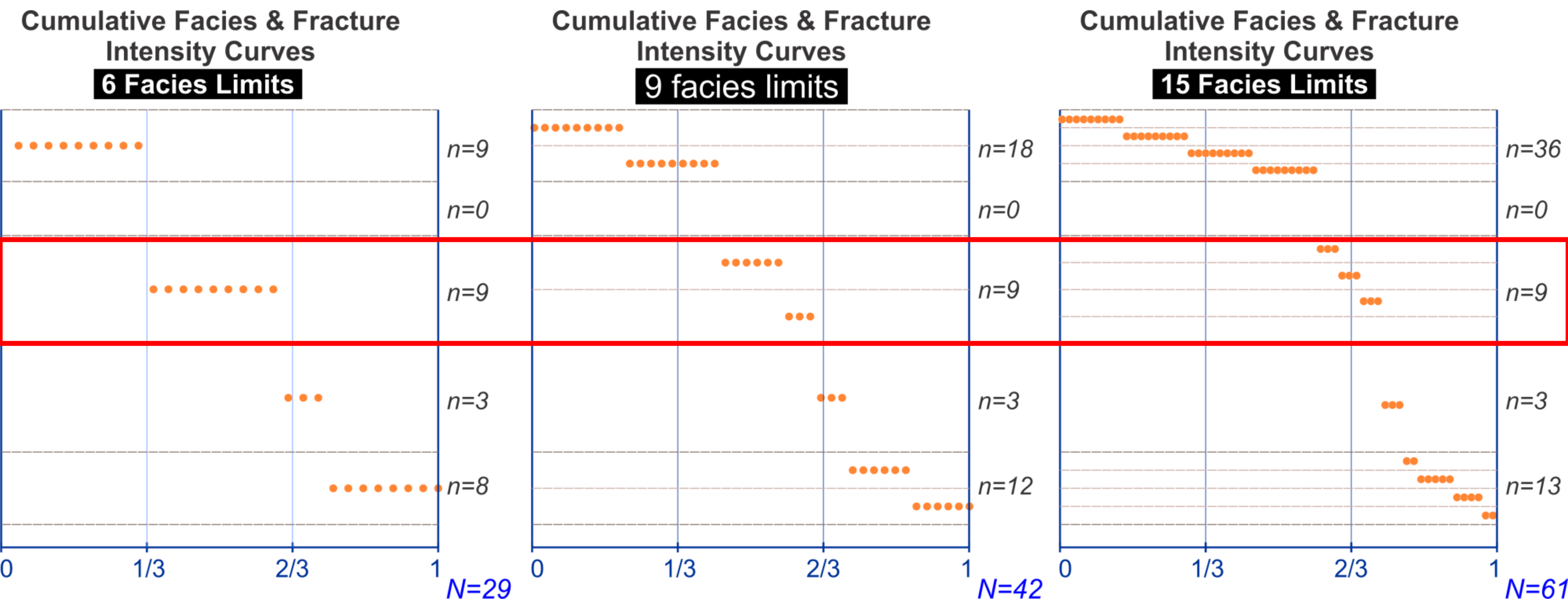


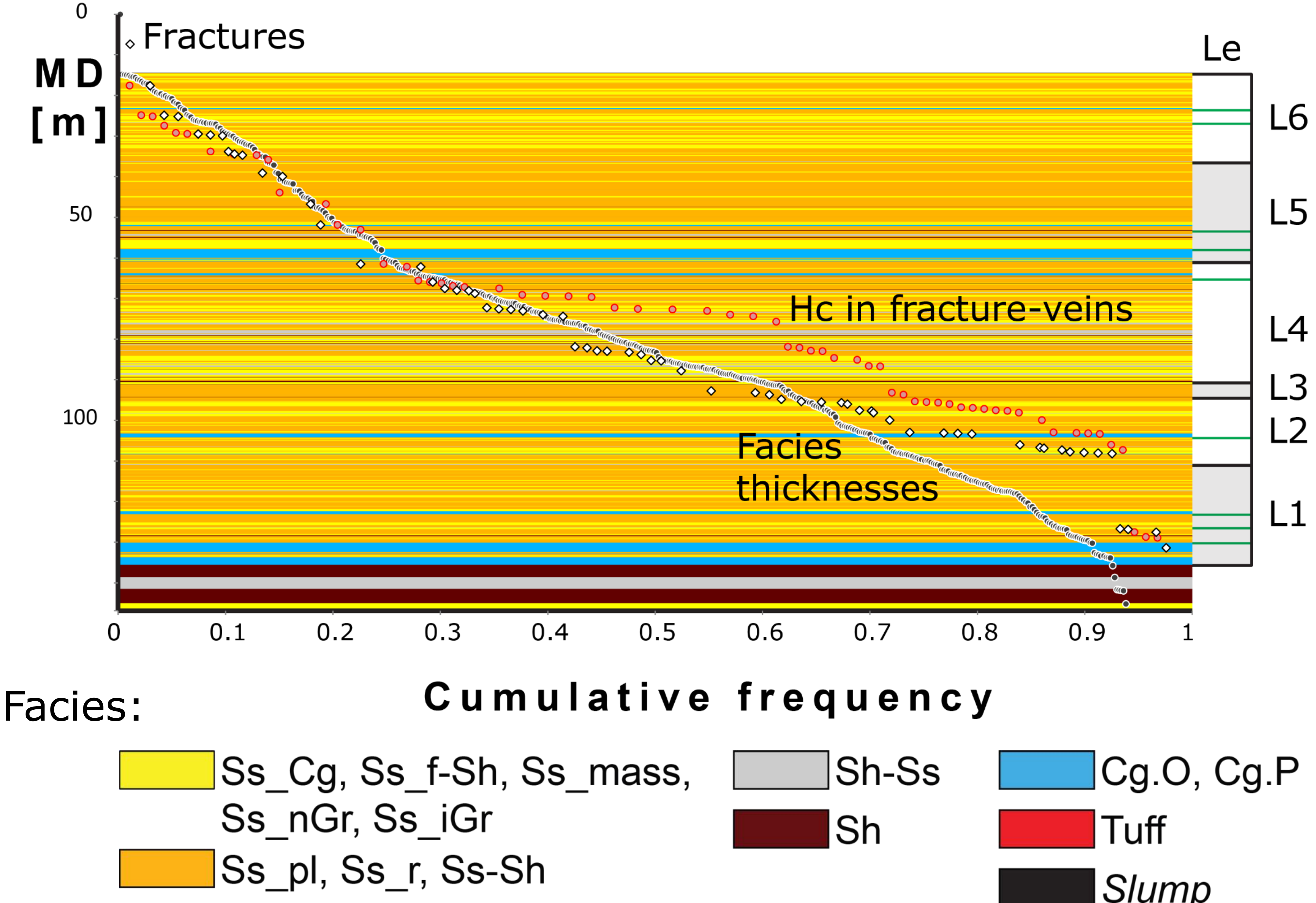
Fracture & Facies Characterization



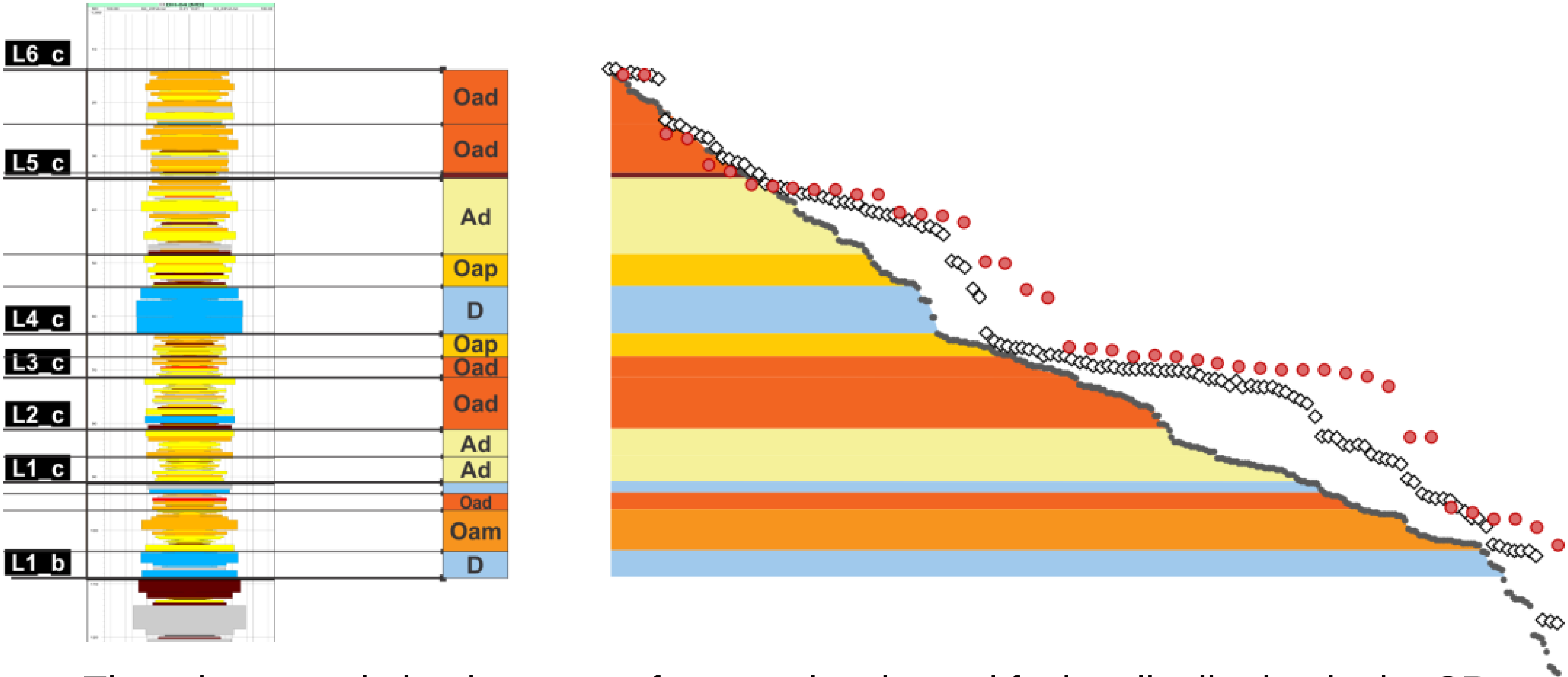
Fracture & Facies Characterization



Cumulative curves for facies and fractures



Conclusions



- There is a correlation beteween fracture density and facies distribution in the SR analogue of the Chicontepec Fm.
- CFI curves allow to identify visually and numerically that correlation.
- The model could be scaled as much as we can group facies.
- Geobodies modelling with fracture attribute, not as discrete element.

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