Shelf to Lower Slope Deposits of an Oversteepened High-Relief Slope Clinoform, Chilean Patagonia*

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Abstract

High-relief slope clinoforms are rarely observed in outcrop. The ability to recognize and study these extensive depositional systems in detail offers an opportunity to understand their fine-scale stratigraphic architecture and formative sedimentary processes. The Tres Pasos and Dorotea formations of the Magallanes basin, Chile, represent shelf, slope and basin-floor deposits of an overall graded, high-relief (>850 m) clinoform system with punctuated, oversteepened intervals. High-relief clinoform work to date has focused on the relationship of shelf-edge trajectories and the accumulation of deepwater reservoir quality sandstone. The objective of this study is to outline the facies distribution, stratigraphic architecture and context of a shelf through lower slope transect along the oversteepened, high-relief "Puma" clinoform.

Parts of at least four clinothems are documented over a 100-km^2 area along a depositional-dip-oriented outcrop belt characterized by ~3500 m of stratigraphy. The dataset consists of high-resolution satellite imagery, extensive measured-section and photo mosaics. The Puma Clinoform is >30 km long (shelf-edge to lower slope) and characterized by 950-m relief. In the overall evolution of the high-relief slope system, the surface is part of a flat shelf-edge trajectory sequence that was associated with delivery of significant coarse detritus to the deep basin. The shelf topset of the Puma clinoform is comprised of river-dominated deltaic deposits. At the shelf edge, both abundant MTDs and slump scars with up to 50 m relief are prevalent and reflect shelf-edge instability. Progradation of deltaic sediments to the shelf edge coupled with extensive mass wasting enhance the overall efficiency of sediment delivery to the deep basin. Approximately 5 km basinward of the shelf edge, the upper slope consists of fine-grained sandstone and siltstone with local incision surfaces overlain by similar facies; coarse-grained detritus largely bypassed the setting. Approximately 22 km from the shelf edge, the lower slope surface consists of conglomerate- and sandstone- filled channel bodies >12 m thick and 200 m wide. These units are dominated by traction structures, indicating significant sediment bypass. Further downslope, conglomerate is absent and channelform sedimentary bodies dominated by thick-bedded sandstone fill are present. These facies observations enable realistic interpretations for analogous hydrocarbon-prone clinoform systems (e.g., Alaska North Slope).

References

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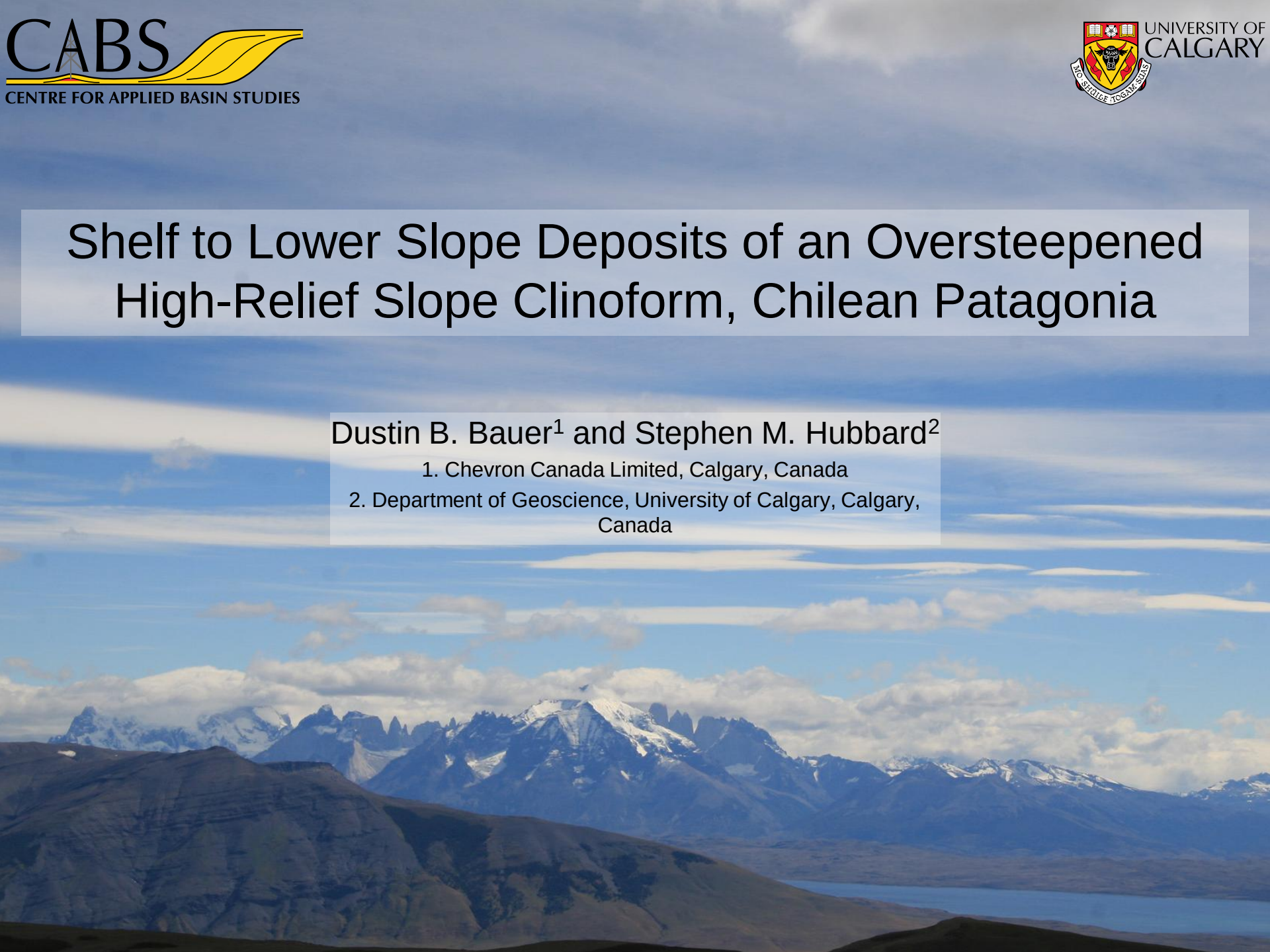
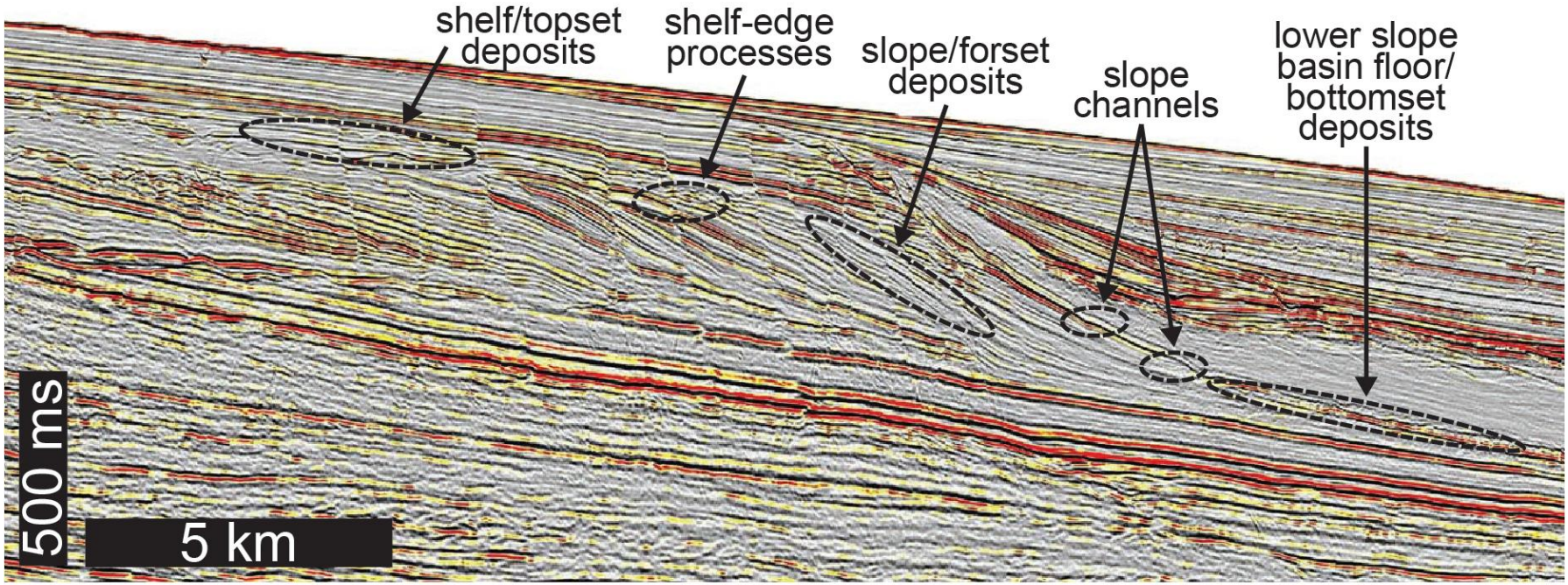


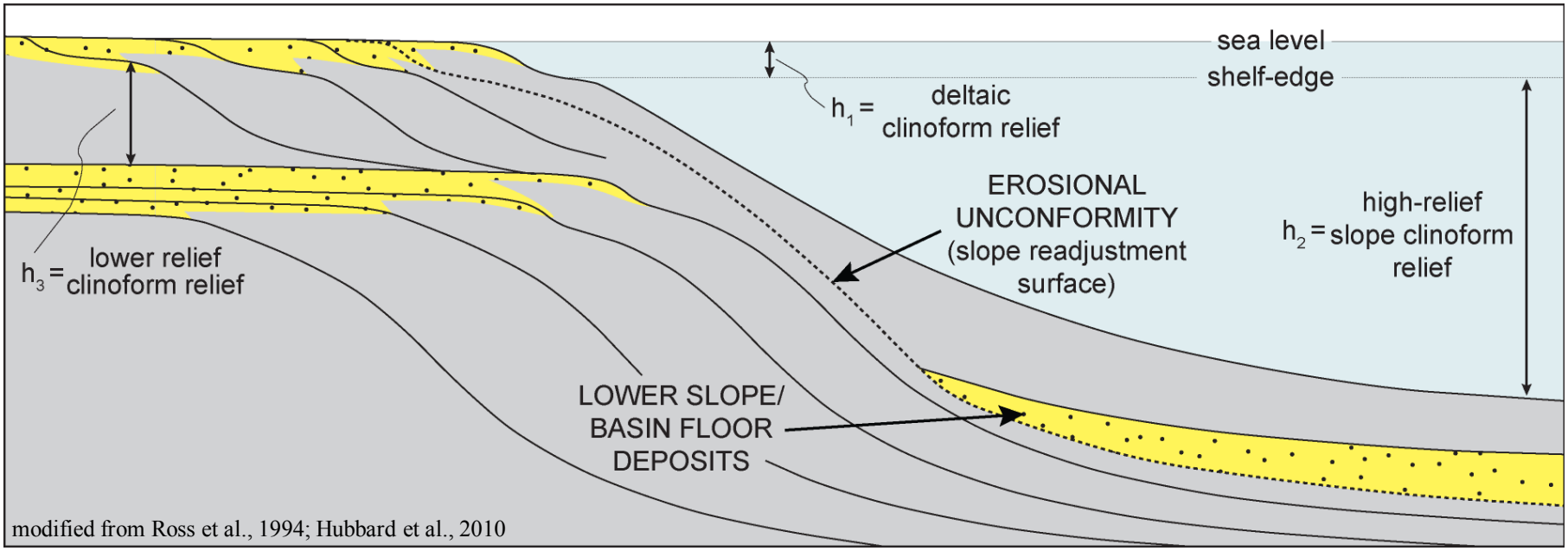
Objectives and Motivation

- Gain insight into the relationship between stratigraphic architecture, sedimentological characteristics and the delivery of sediment beyond the shelf-edge
- Map a high-relief (>1000 m) slope surface in outcrop

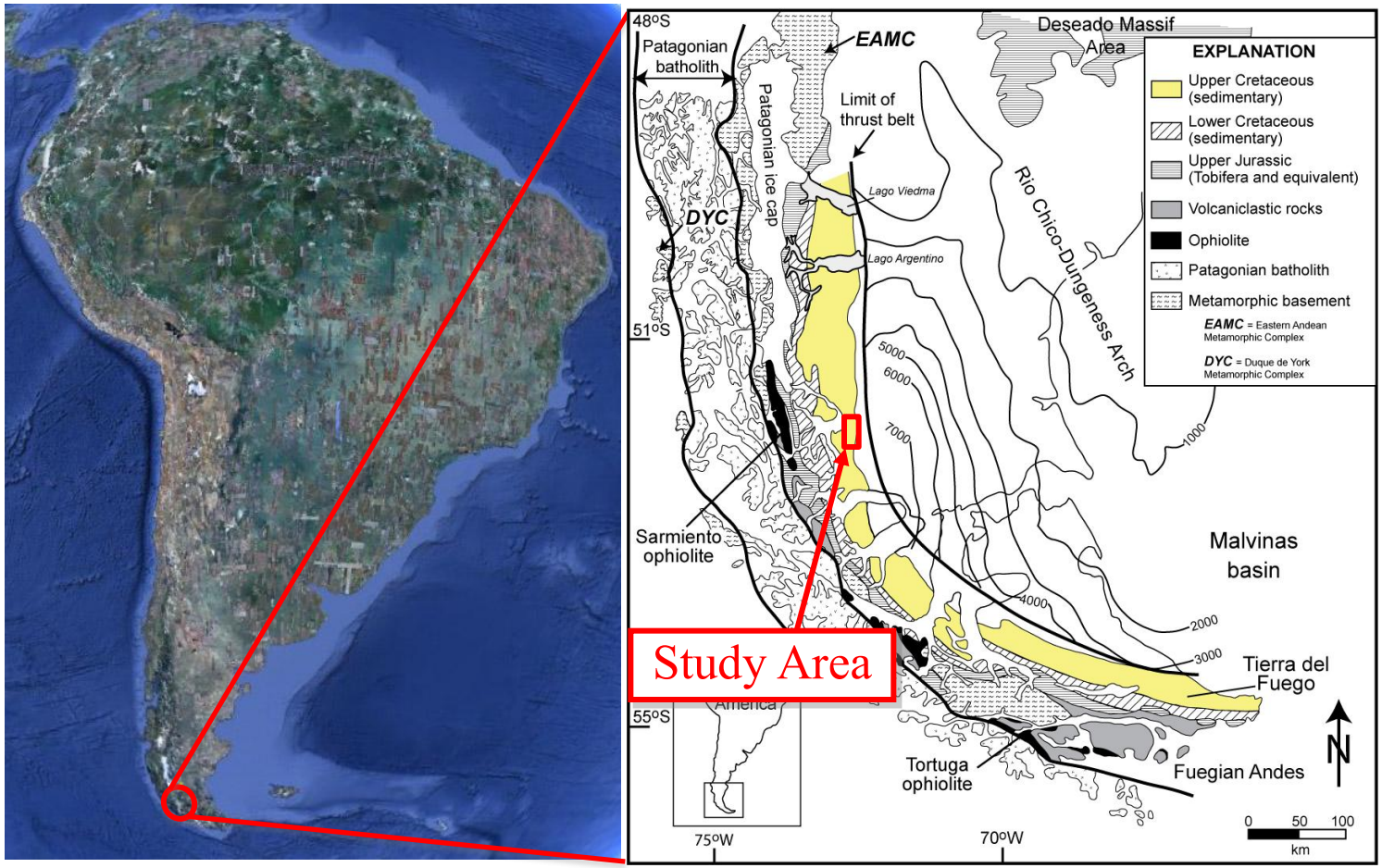


Objectives and Motivation

- Shelf-edge processes and shelf-edge trajectory both linked to volume of sediment delivered to the deep-sea by previous workers
- We demonstrate that these factors are minor in comparison to major margin readjustment and development of oversteepened slope conditions (cf. Ross et al., 1994)



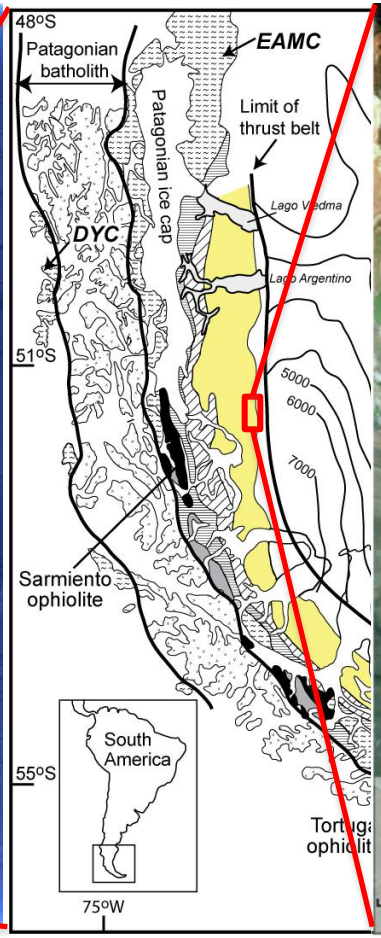
Magallanes Foreland Basin Study Area



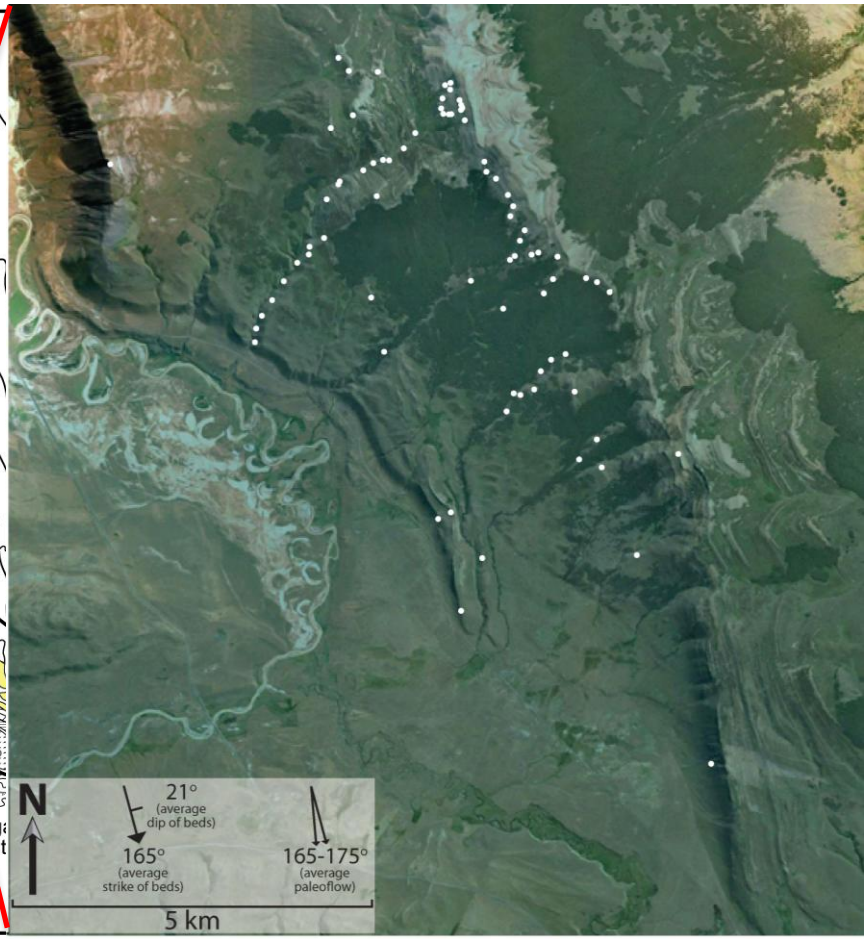
(Fildani and Hessler, 2005)

southern end of 7000-km-long Andean Cordillera

Magallanes Foreland Basin Study Area



(Fildani and Hessler, 2005)

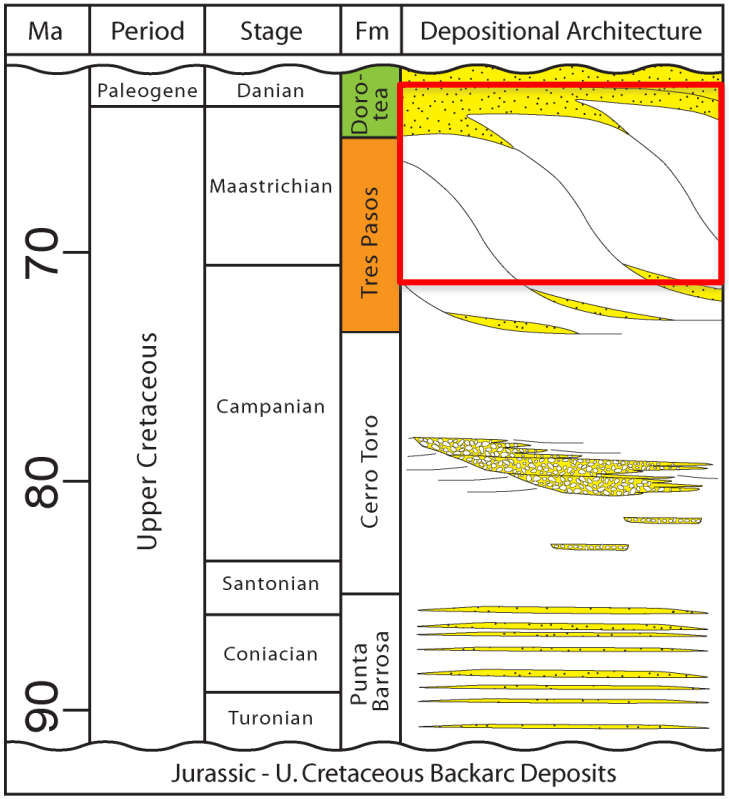


southern end of 7000-km-long Andean Cordillera

~3000 m of stratigraphic section from > 50 outcrop locations

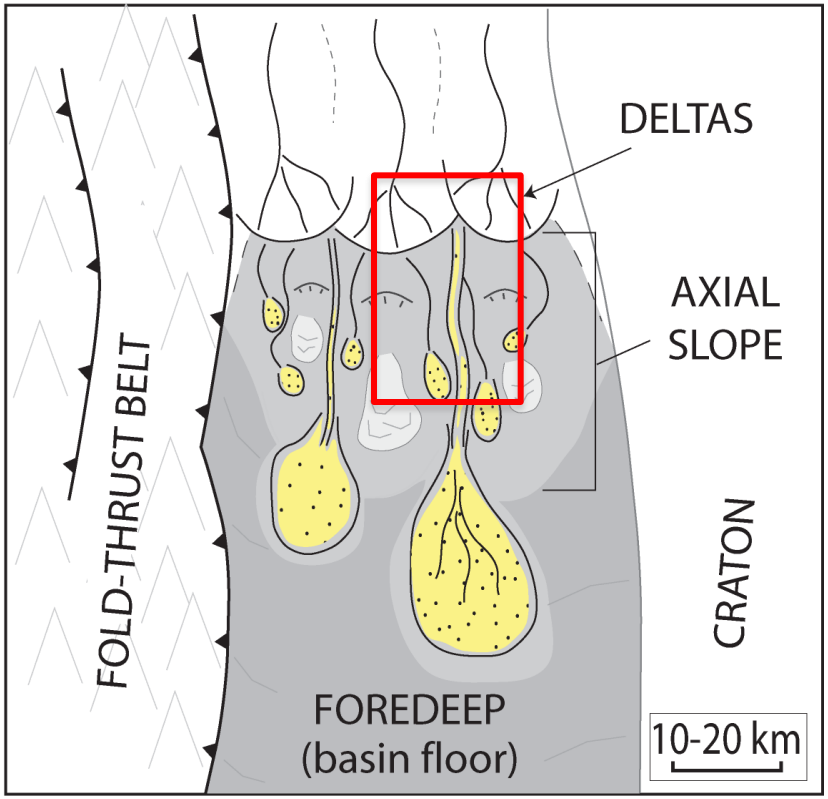
Magallanes Foreland Basin Study Area

Stratigraphy



based on Fildani et al., 2003

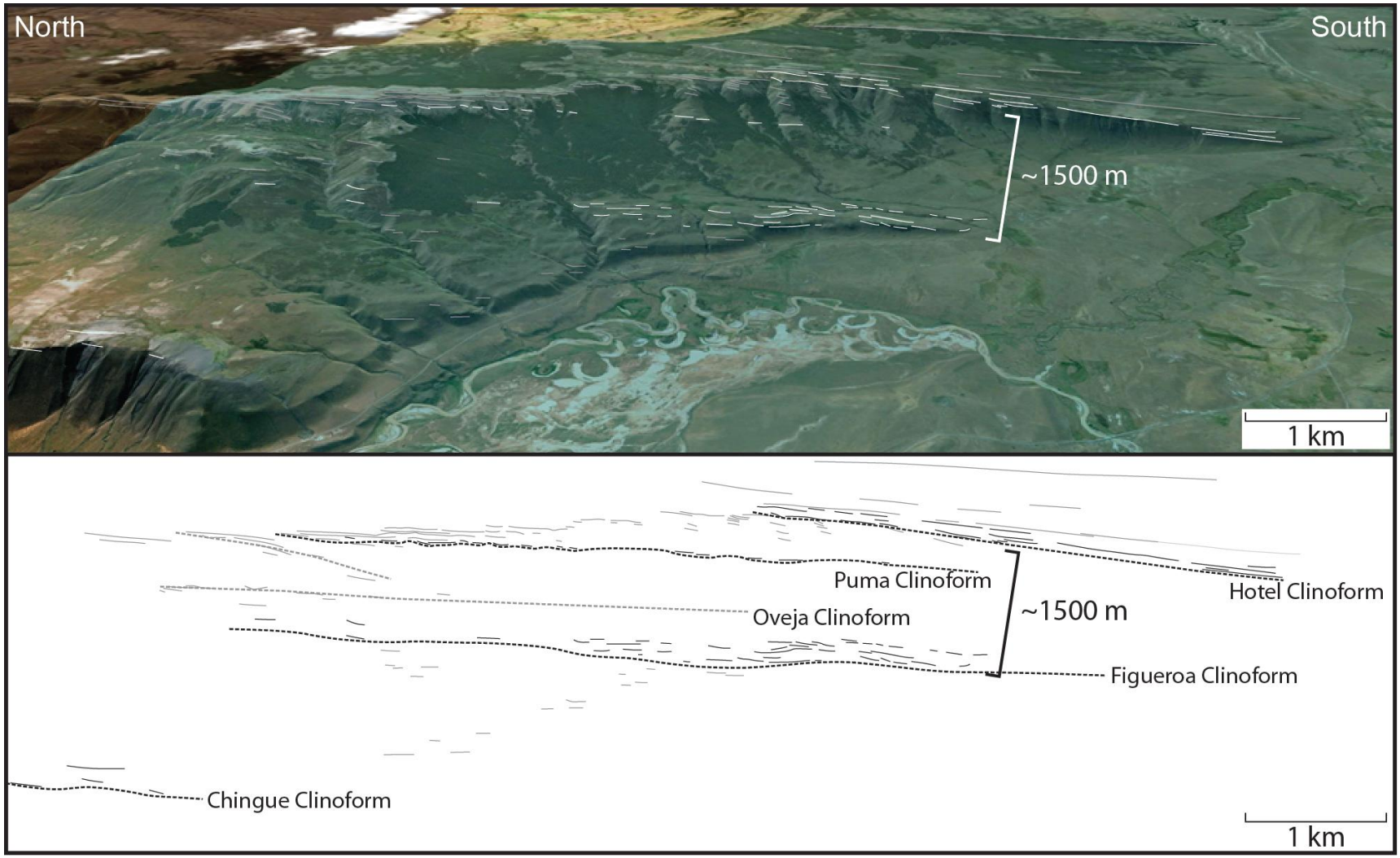
Paleogeography



modified from Fildani et al., 2009; Hubbard et al., 2010

Magallanes Basin was ultimately filled by a southward (basin axial) progradational high-relief >1000 m slope clinoform system

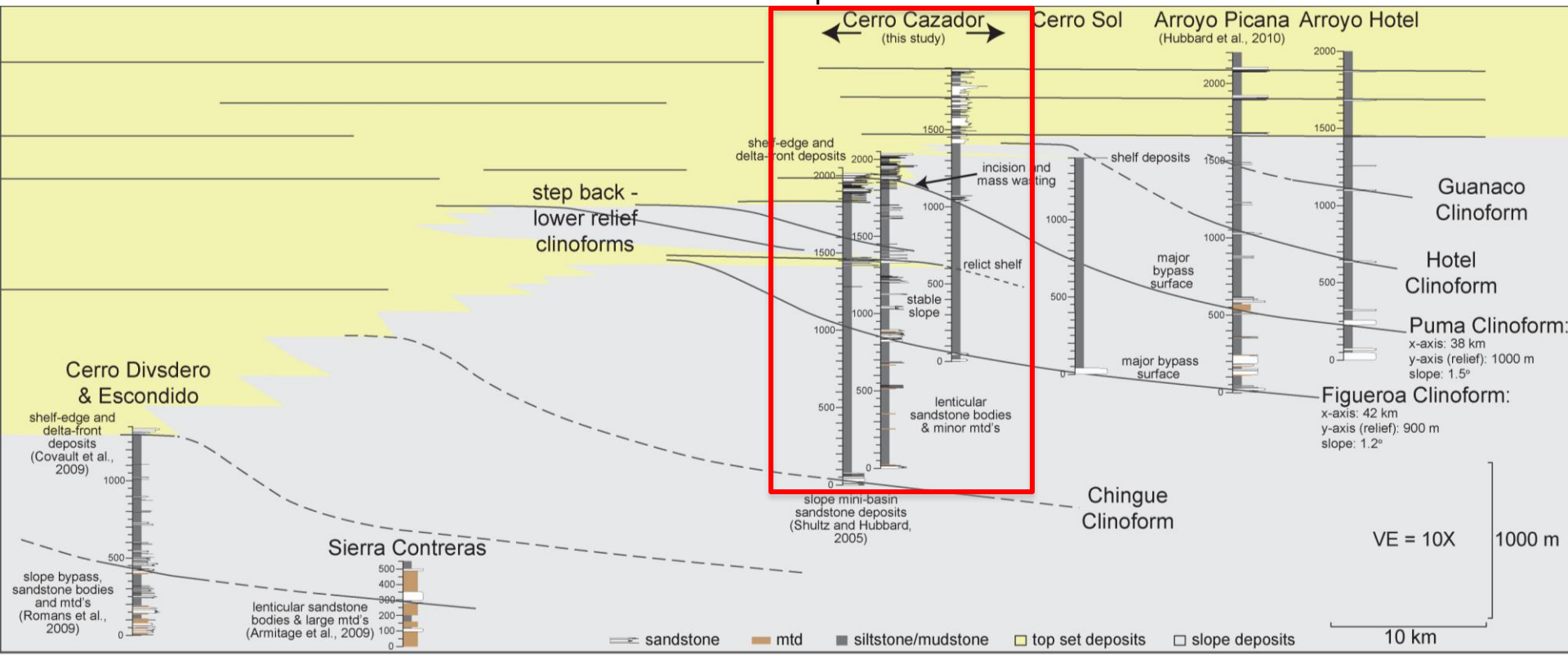
Depositional Dip-Oriented Cross-Section Exposure



Outcrop Belt Stratigraphic Architecture

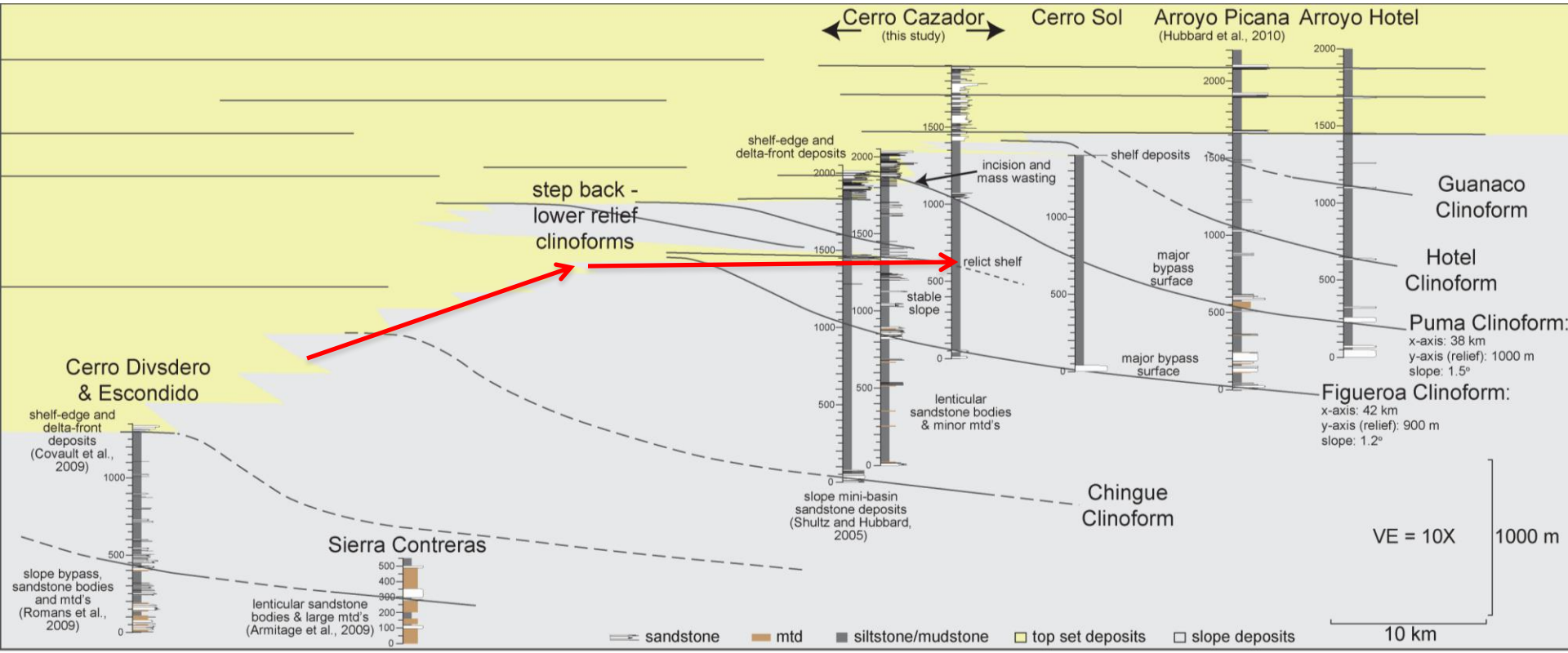
Magallanes Basin High-Relief Clinoform System

previous slide



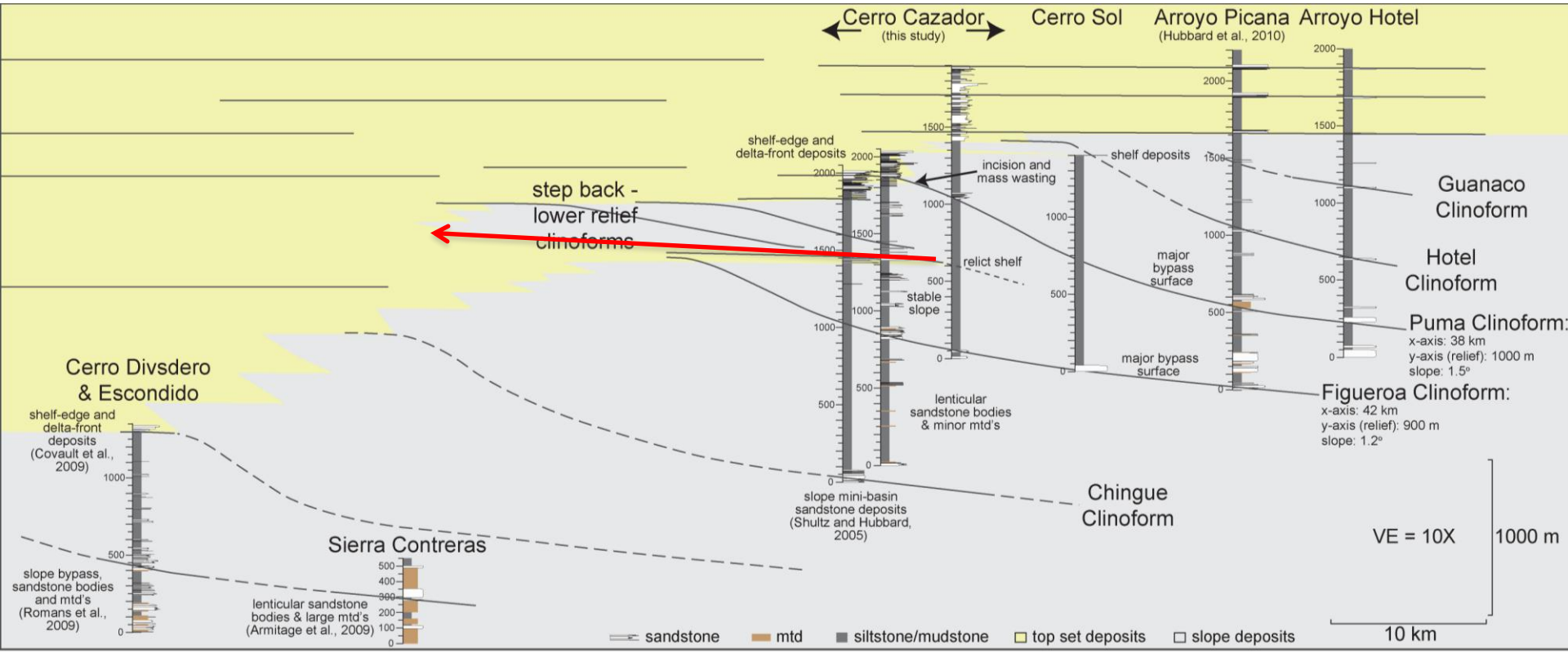
Stratigraphic Evolution of the Tres Pasos-Dorotea System

Long-Lived Shelf-Edge Progradation (Rising to Flat Trajectory)



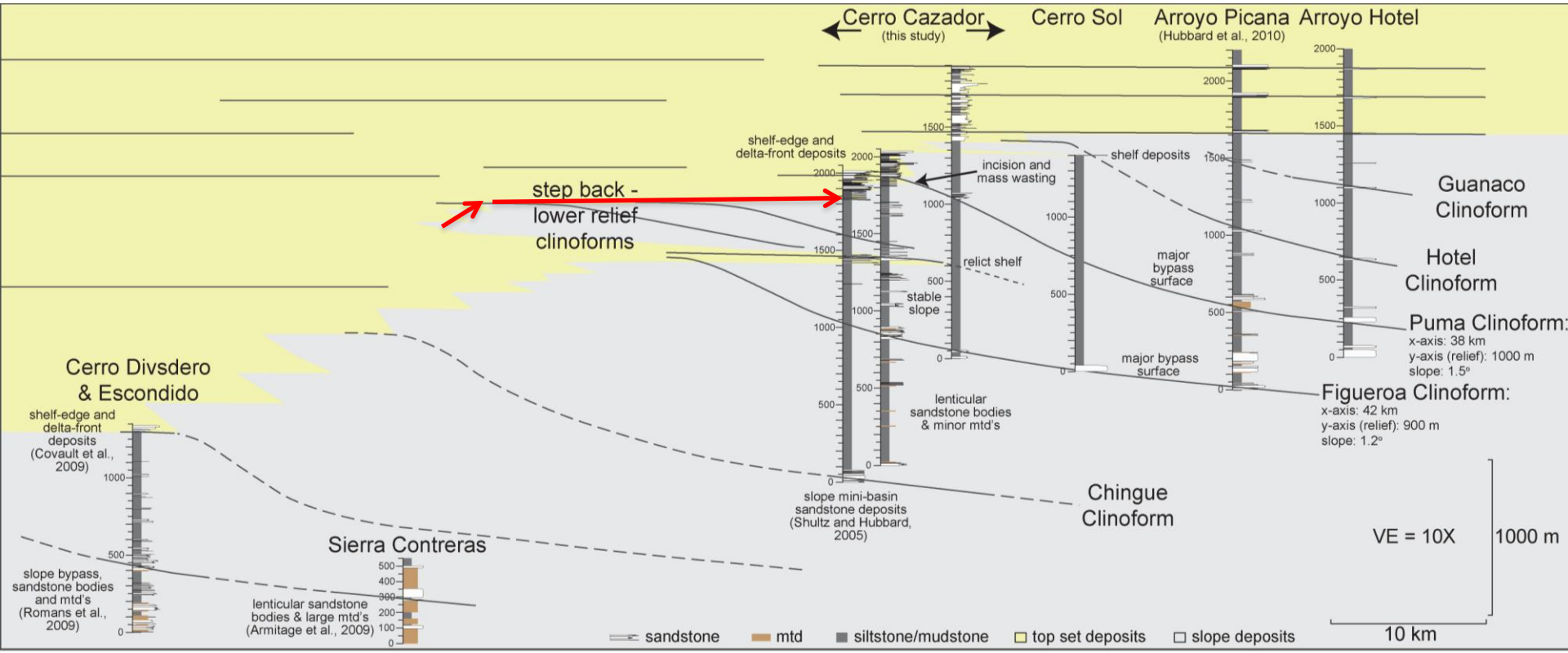
Stratigraphic Evolution of the Tres Pasos-Dorotea System

Major Shelf-Edge Step Back



Stratigraphic Evolution of the Tres Pasos-Dorotea System

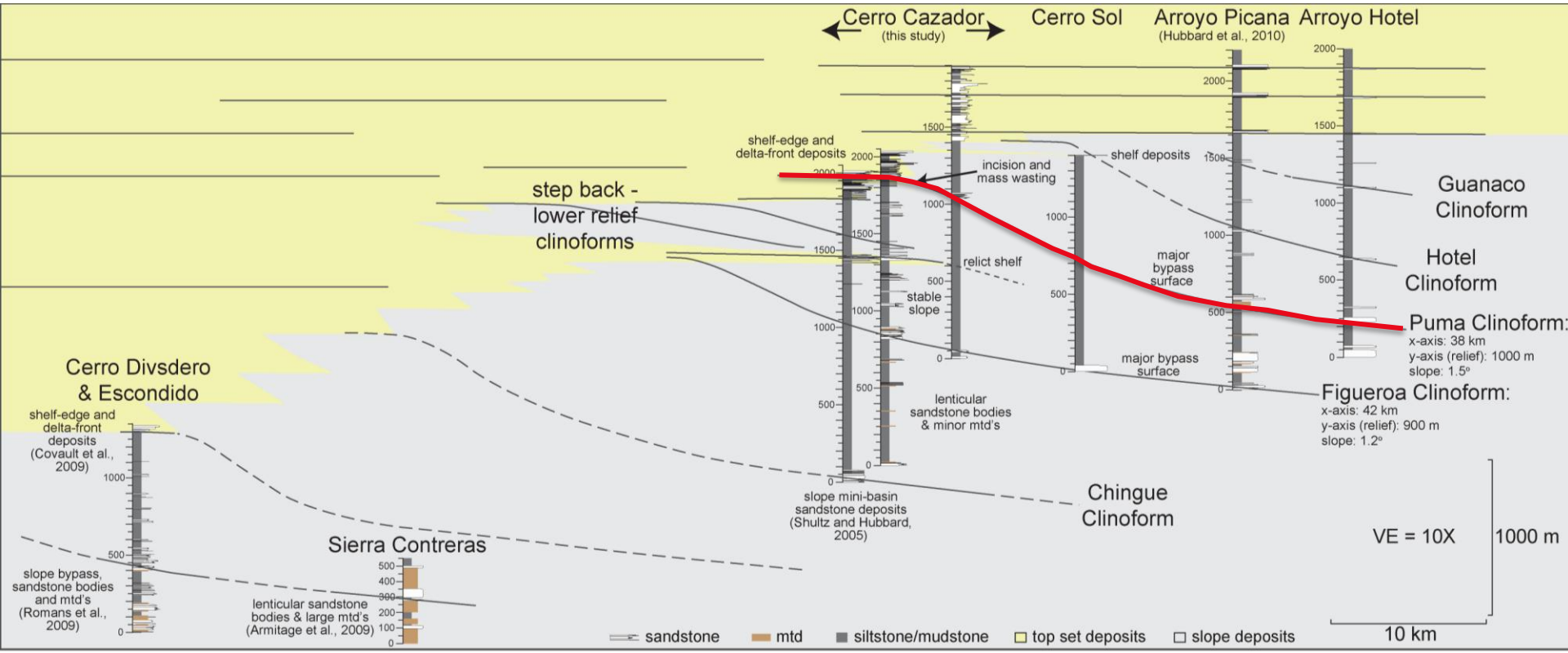
Lower Relief Clinoforms Develop on the Relict Shelf



- Aggradation to progradation of clinoforms 200-300 m thick

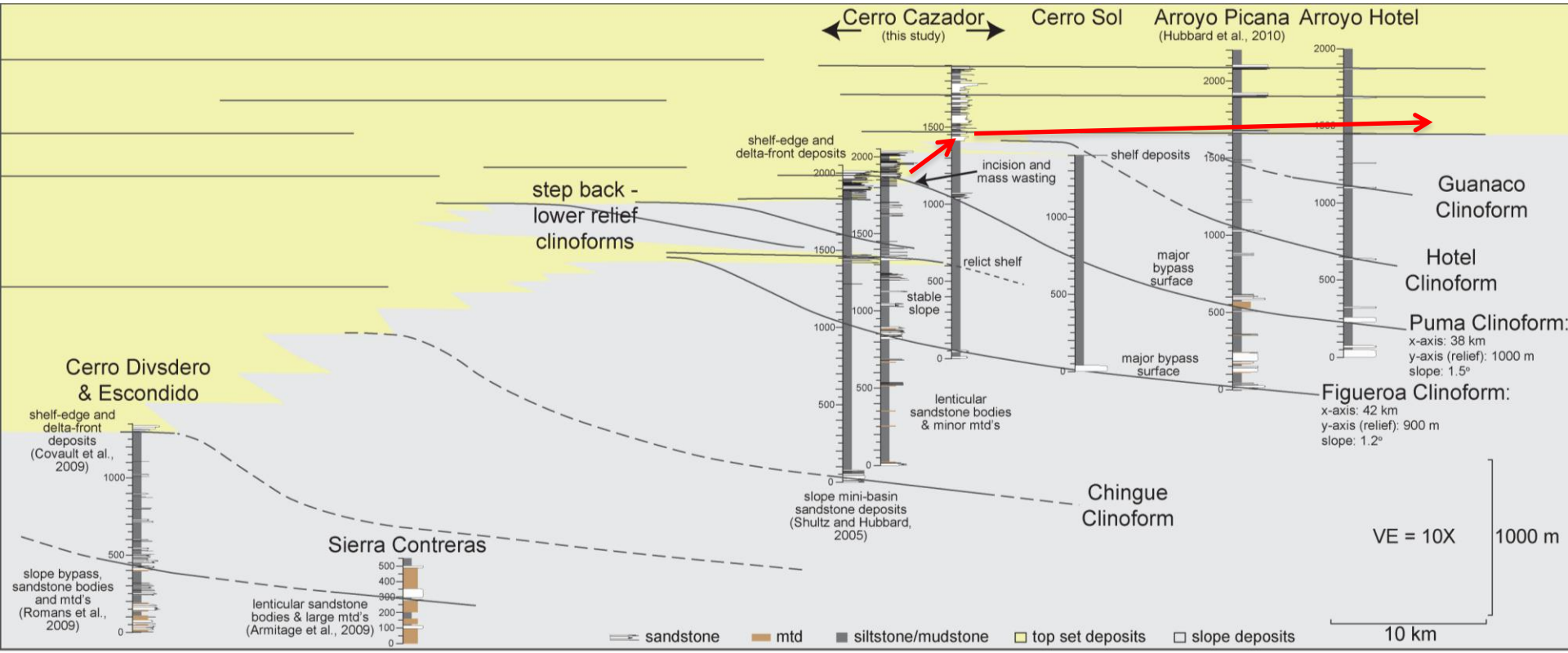
Stratigraphic Evolution of the Tres Pasos-Dorotea System

Lower-Relief Clinoforms Reach the Relict High-Relief Shelf-Edge and an Oversteepened Slope Develops



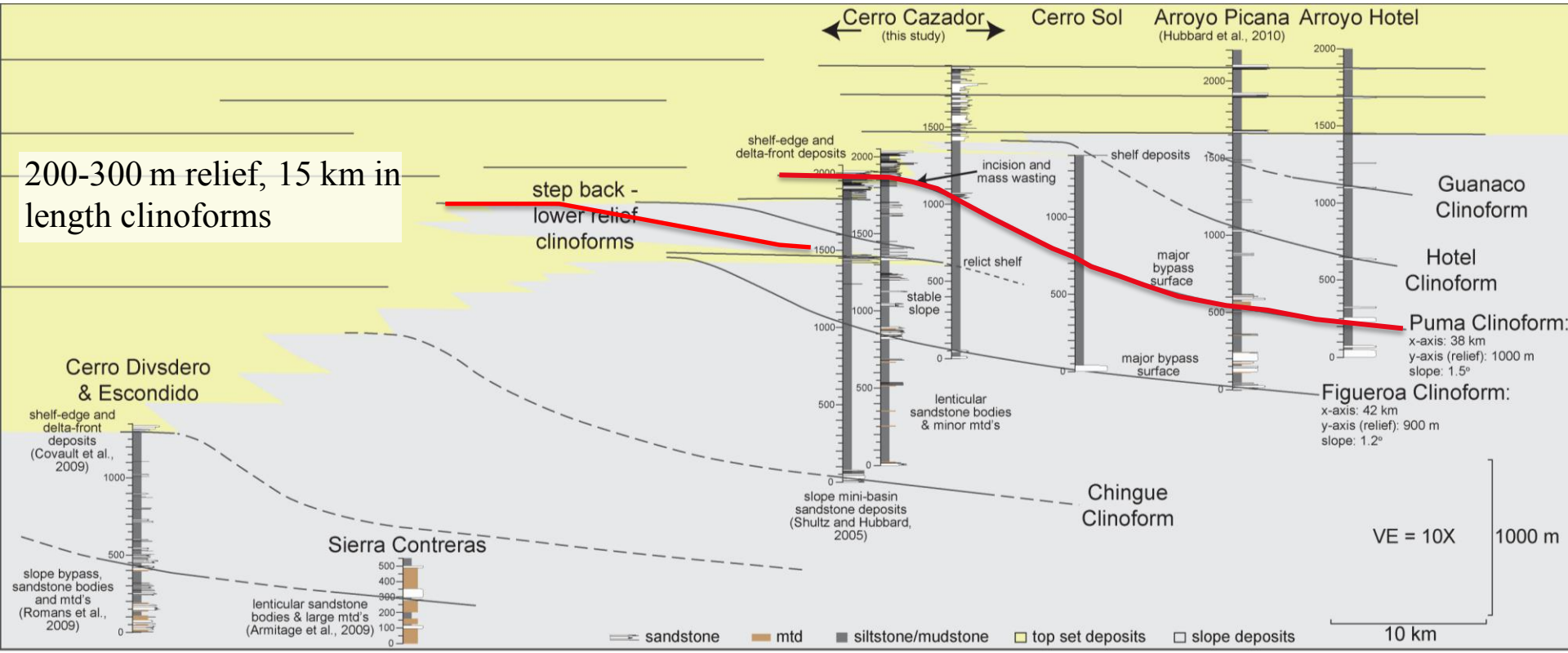
Stratigraphic Evolution of the Tres Pasos-Dorotea System

Period of Long-Lived Margin Progradation Established

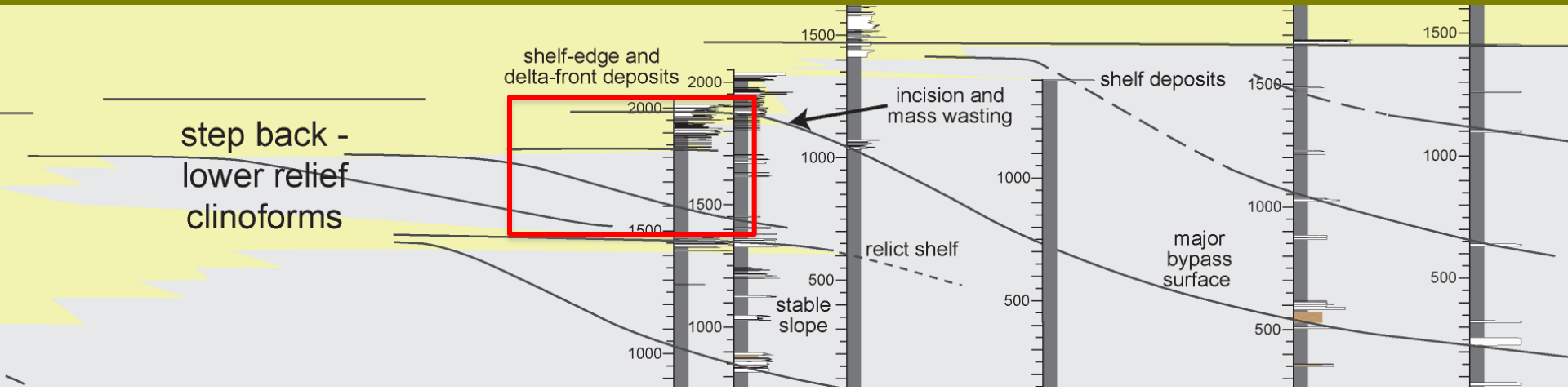


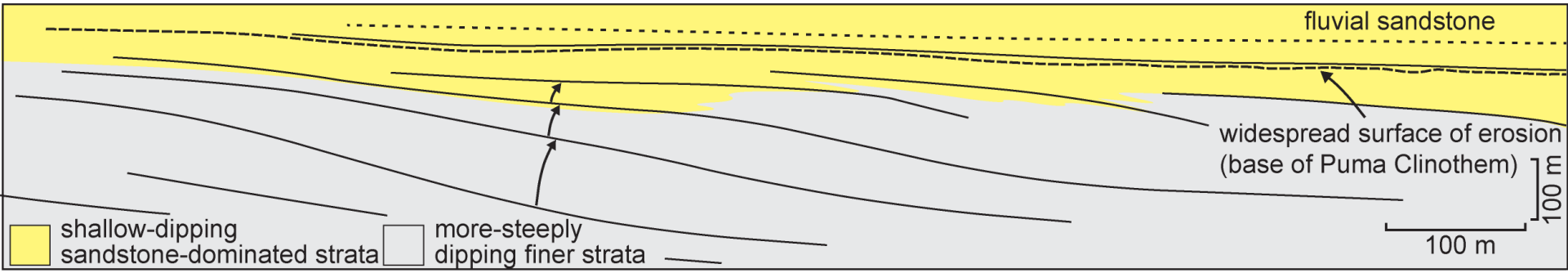
Presentation Focus Puma Clinoform – Oversteepened Slope

1000 m relief, 38 km in length



Stage 1: Progradation of Lower-Relief Clinoforms





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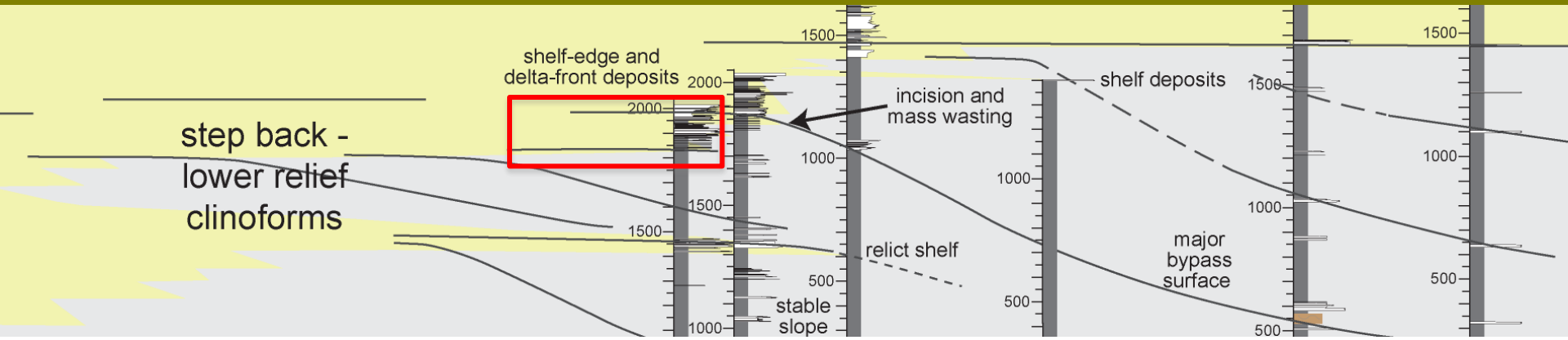
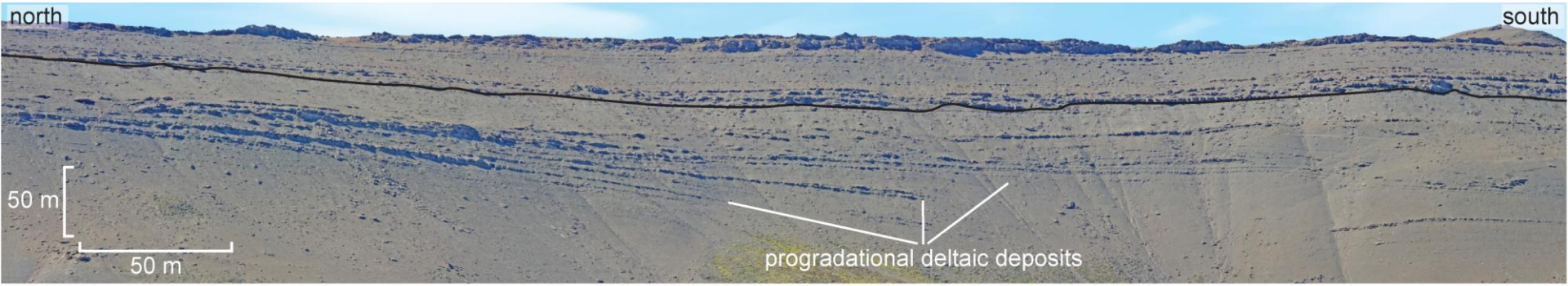
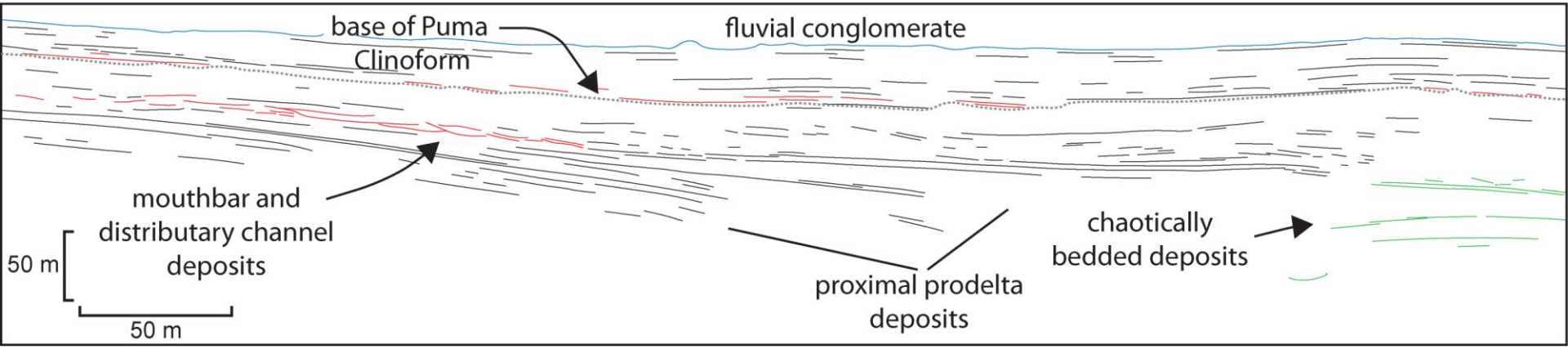
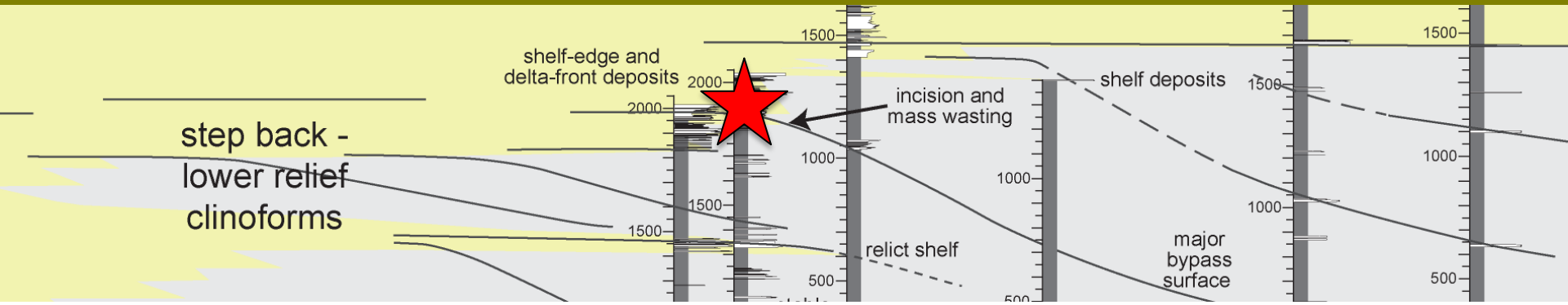
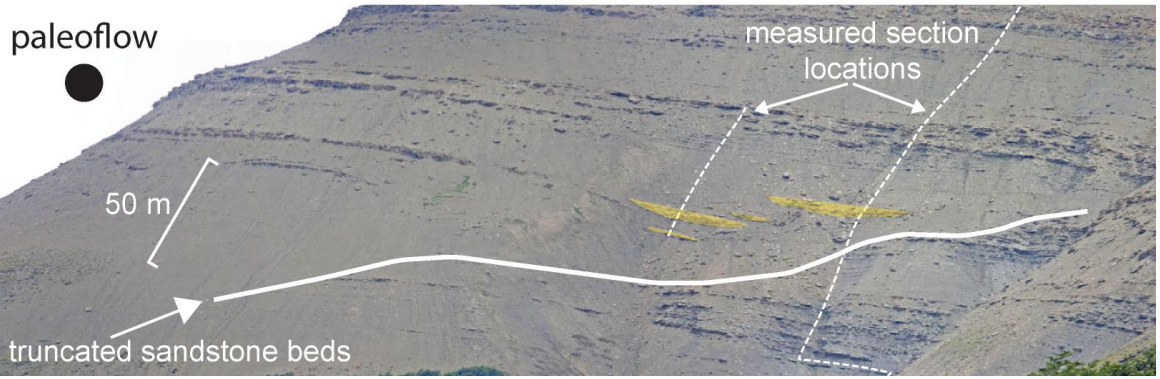




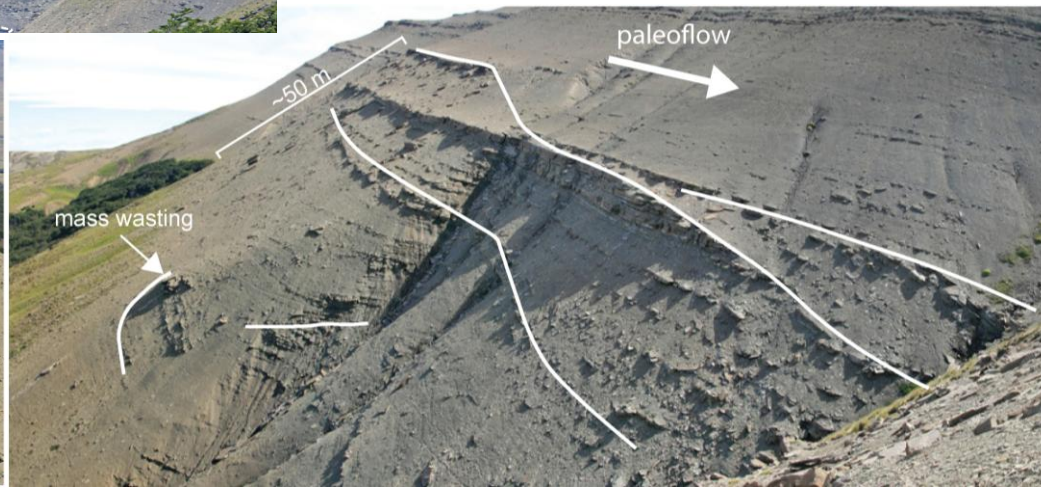


Stage 2: Lower-Relief Clinoforms Reach Relict Shelf-Edge

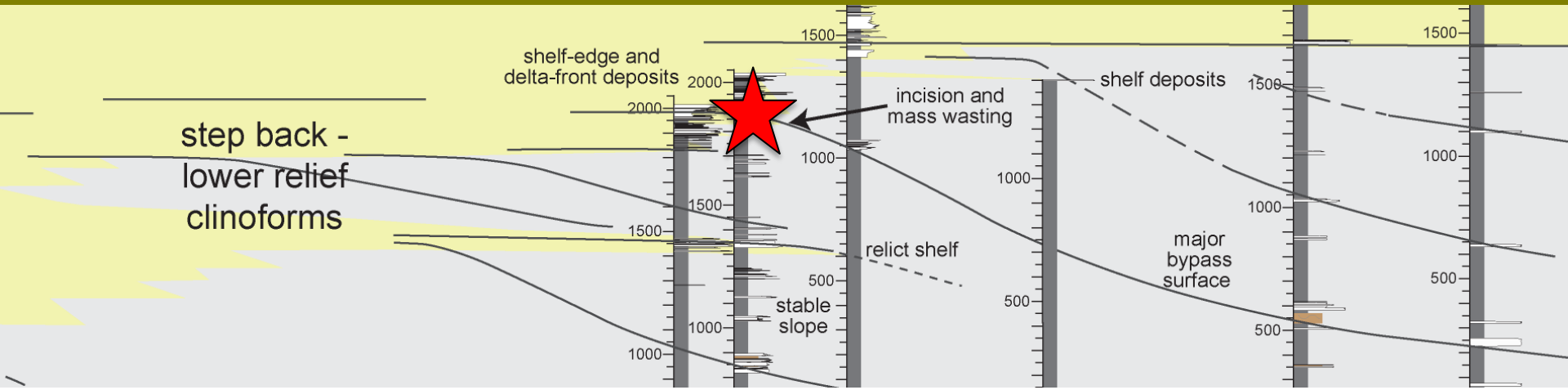




- Laterally extensive incisions up to 60 m deep
- Mass wasting along shelf-edge

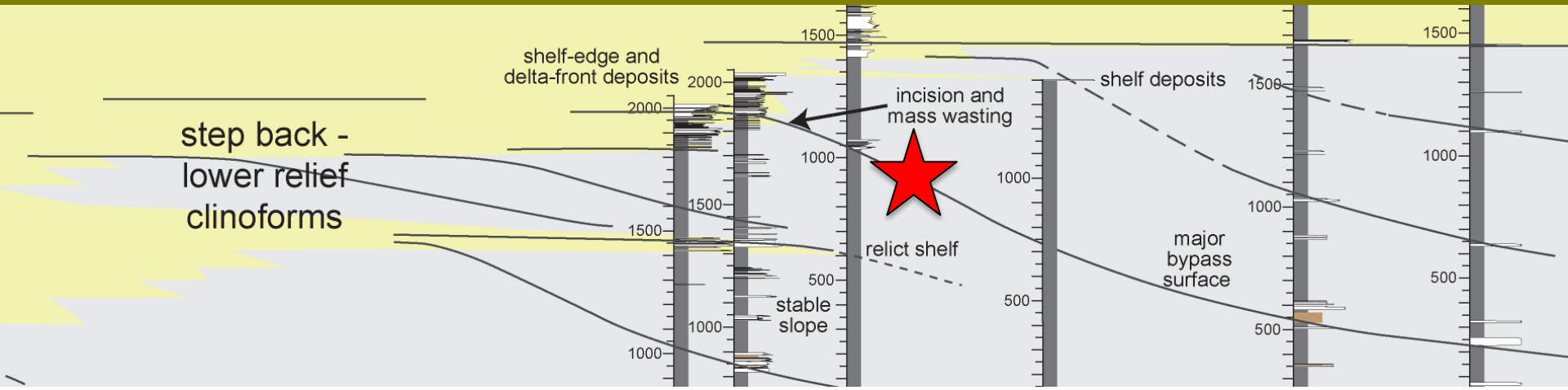


Stage 2: Lower-Relief Clinoforms Reach Relict Shelf-Edge



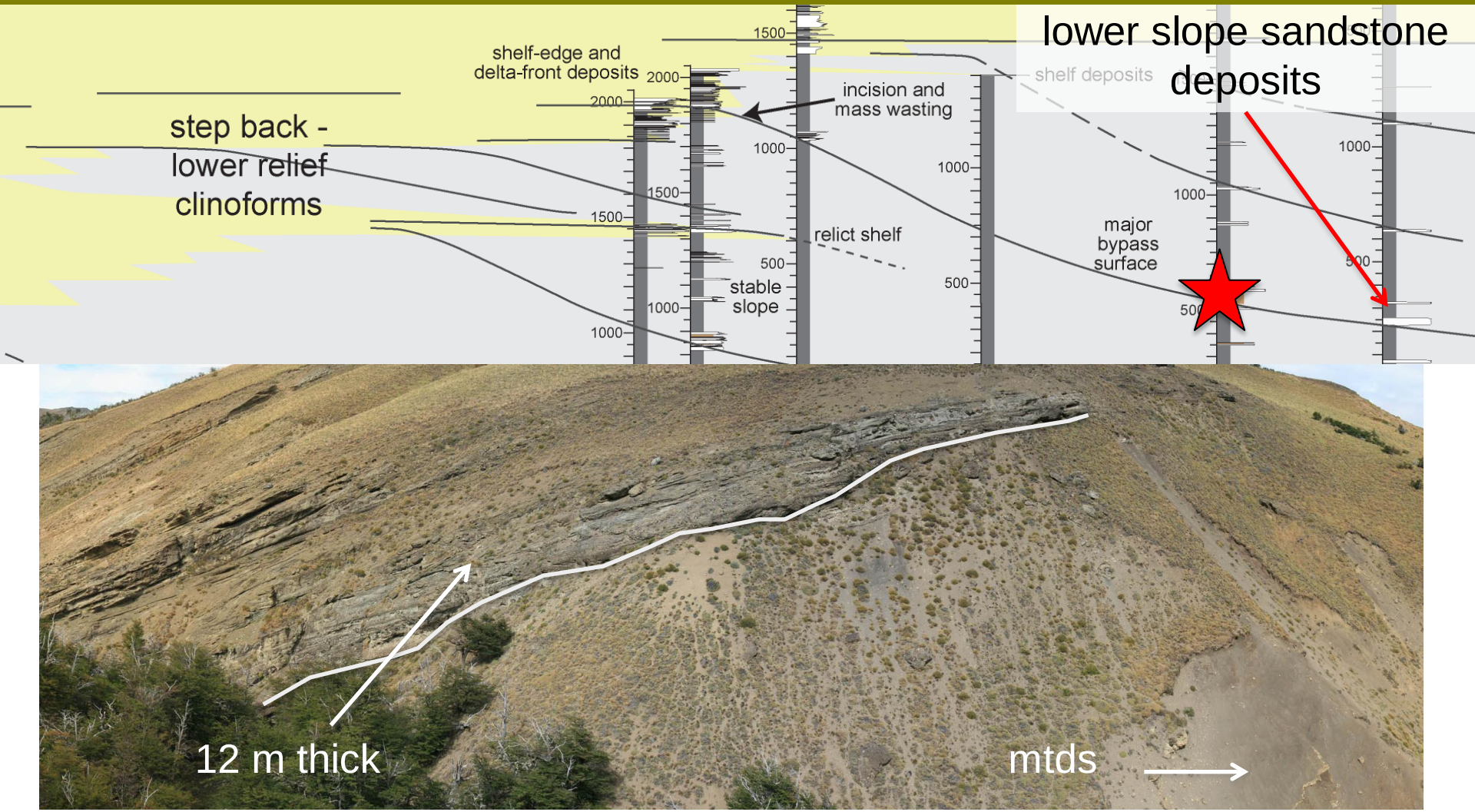
- erosional surfaces up to 25 m deep: background deposits and incision infill same facies

Stage 3: Sediment Bypass on Upper Slope



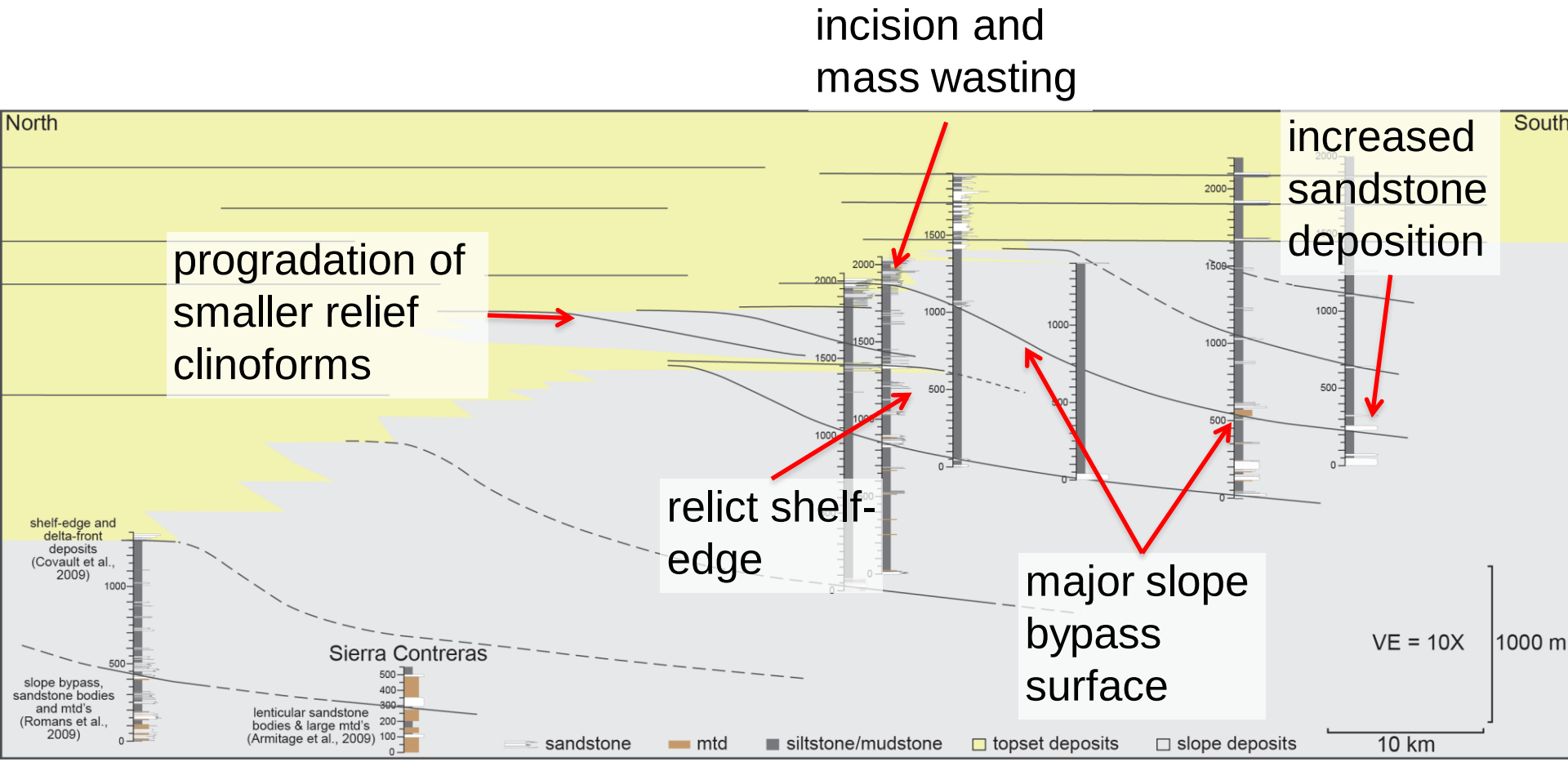
- Numerous low-relief incisions: background deposits and incision infill same facies

Stage 3: Accumulation of Coarse-Grained Material on Lower Slope



- Channelform conglomeratic bodies at lower slope

Presentation Summary and Conclusions



Presentation Summary and Conclusions

- Long-lived southward-prograding clinoform system exposed in Magallanes Basin outcrops
- Shelf-edge trajectory and detailed analysis of shelf sedimentology assessed in the study area and neither factor is apparently critical in terms of sediment delivery beyond the shelf edge
- Substantial coarse-grained sediment accumulation at the lower- to toe-of-slope tied to major shelf-margin readjustment and the development of oversteepened conditions (cf. Ross et al., 1994)

Acknowledgments

Collaborators:

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