Deepwater Channel Bypass and Deepwater Channel Bypass and Backfilling Processes from the Eocene Ainsa Basin, South-Central Pyrenees, Spain*

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Abstract

Deepwater channel outcrops in the Eocene Ainsa Basin have been previously well documented. The work presented here, however, focuses on evidence of turbidity current bypass and backfilling. Channel bases are characterized by a composite erosional surface with significant incision and scouring, and facies comprising scoured thin beds, fine-grained drapes, relatively coarse-grained bars and mud-rich debrites. Above this, channel fills are generally finer-grained thick-bedded sand facies. In the channel axes thick-bedded facies are commonly amalgamated, with dewatering and flame structures. Towards the margin these facies change laterally to thinner inter-bedded graded sandstones.

These observations imply that numerous relatively high velocity turbidity currents were responsible for cutting the channels, with the majority of the sediment load bypassing down slope. Increases in flow velocity can either be related to changes in the staging area of the flows, or an increase in the channel floor gradient as channels attempt to establish equilibrium gradients on an irregular or dynamic slope. Seismic data from analogous subsurface systems suggests that the latter is a very common process in controlling channel architecture. In many channels, after the initial bypass phase, flows with a lower velocity backfill the channel resulting in rapid sand deposition. Debris flow deposits within channels are considered to be random events, but their common association with bypass facies may be related to the longevity of the bypass phase relative to the backfilling phase.

Processes of bypass and backfilling operate at different scales, magnitudes and frequencies, resulting in a hierarchy of channelized stratigraphy with predictable facies associations. Generic models deriving from this work can be used to aid interpretation and modeling of analogous reservoirs.

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With contributions from Chuck Stelting, Will Schweller, Tim McHargue, Morgan Sullivan & Kevin Pickering*

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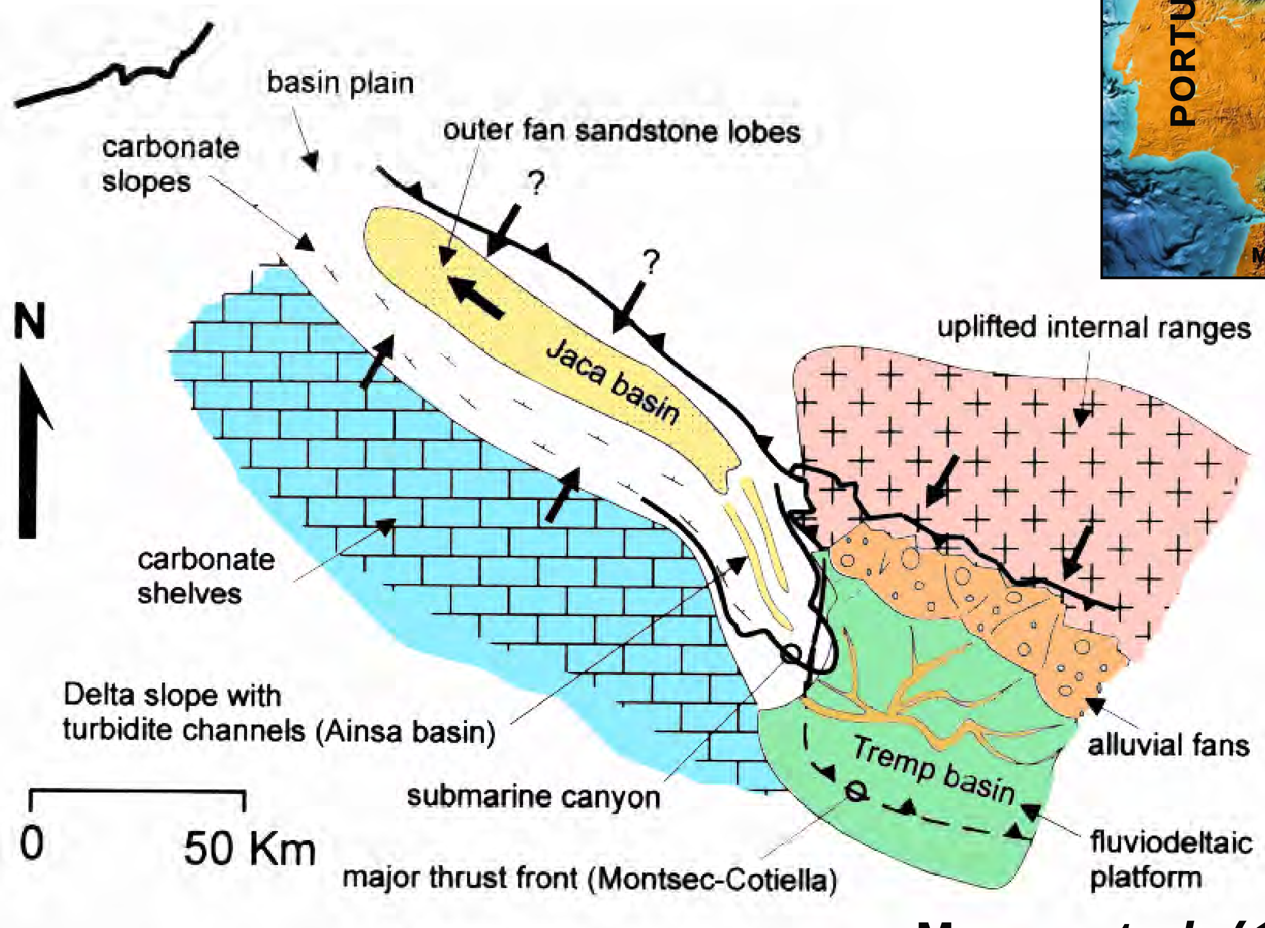
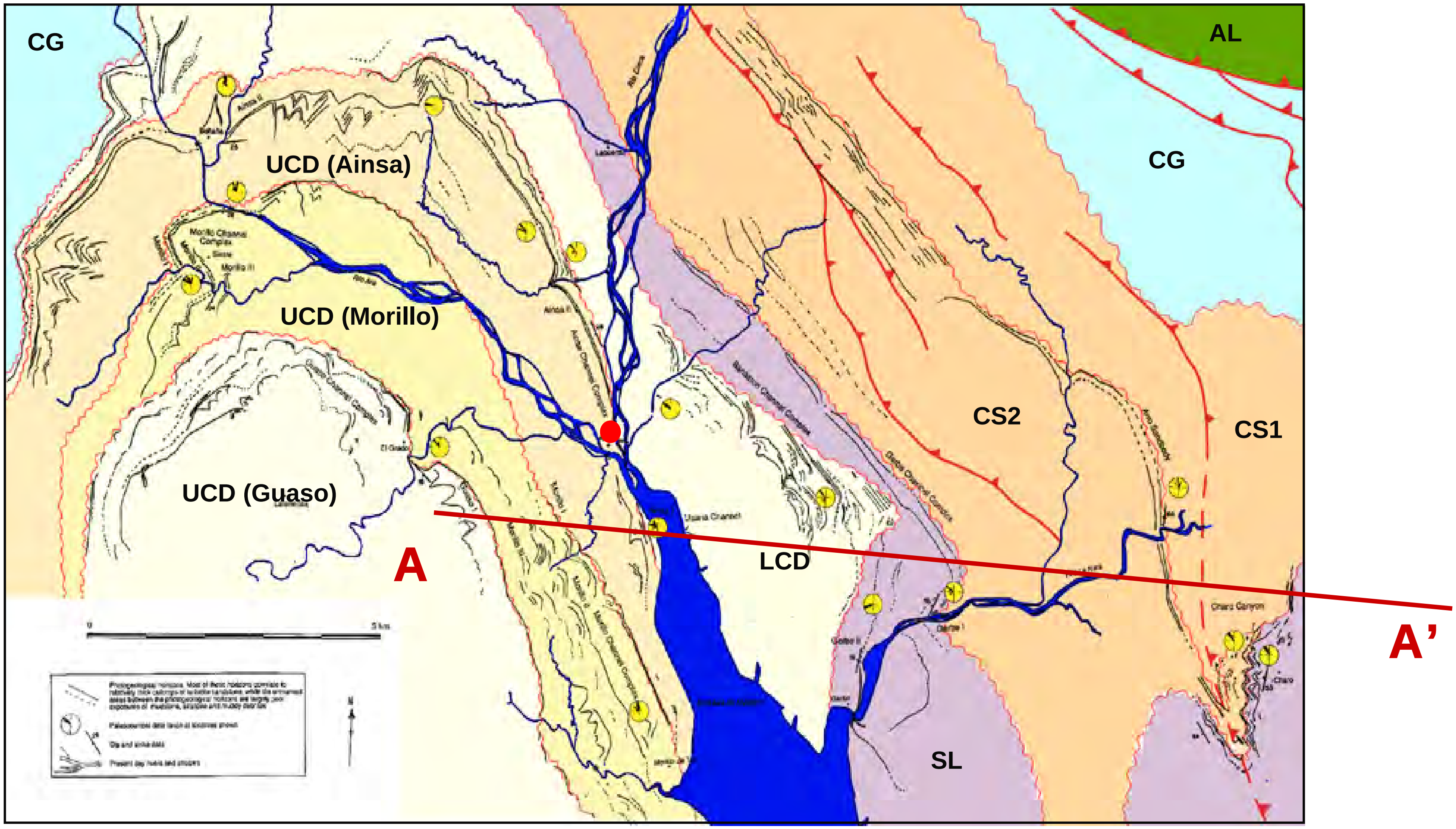
Paleogeography



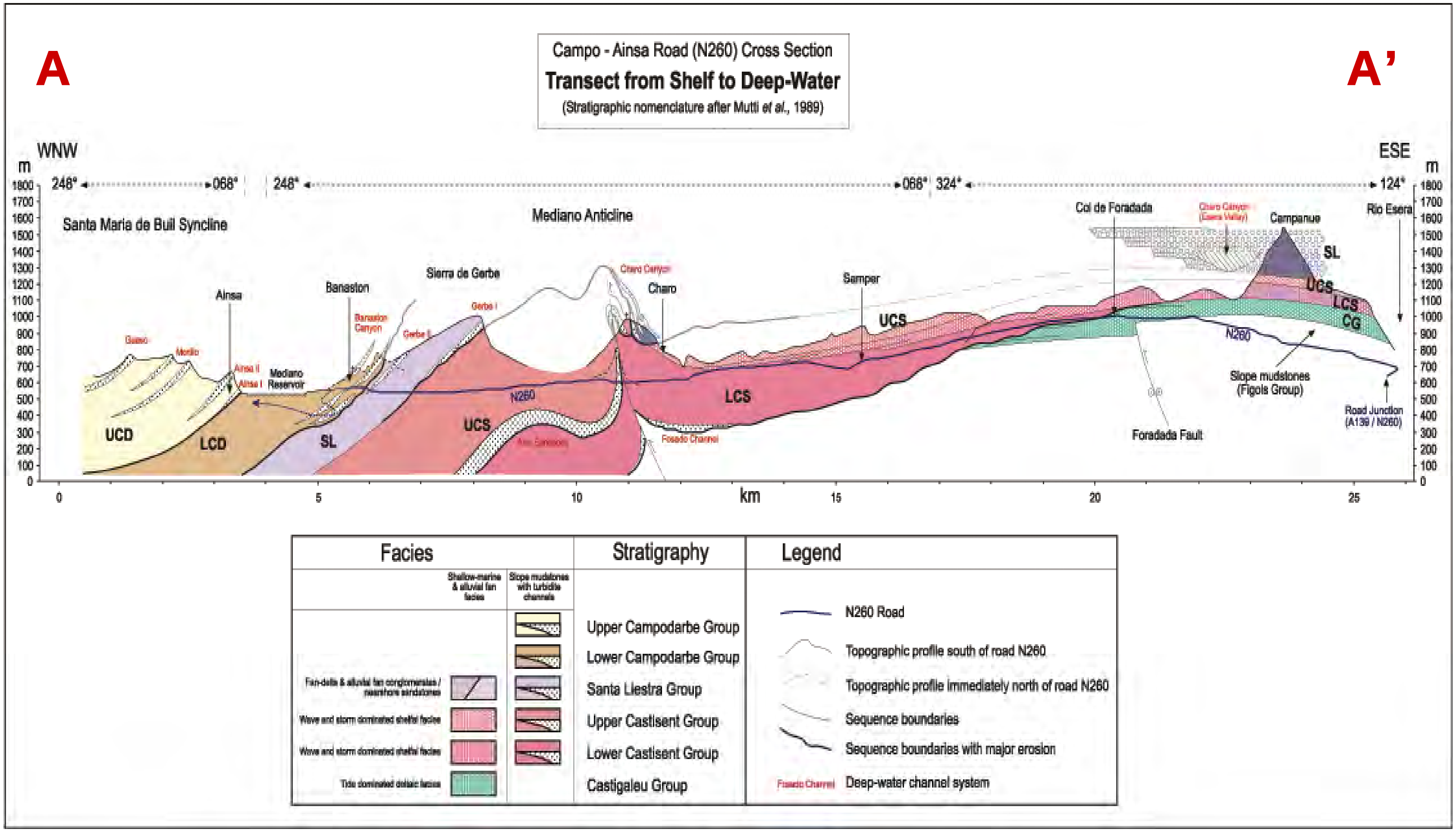
Marzo *et al.* (1998)

Channels & Canyons of the Ainsa Basin

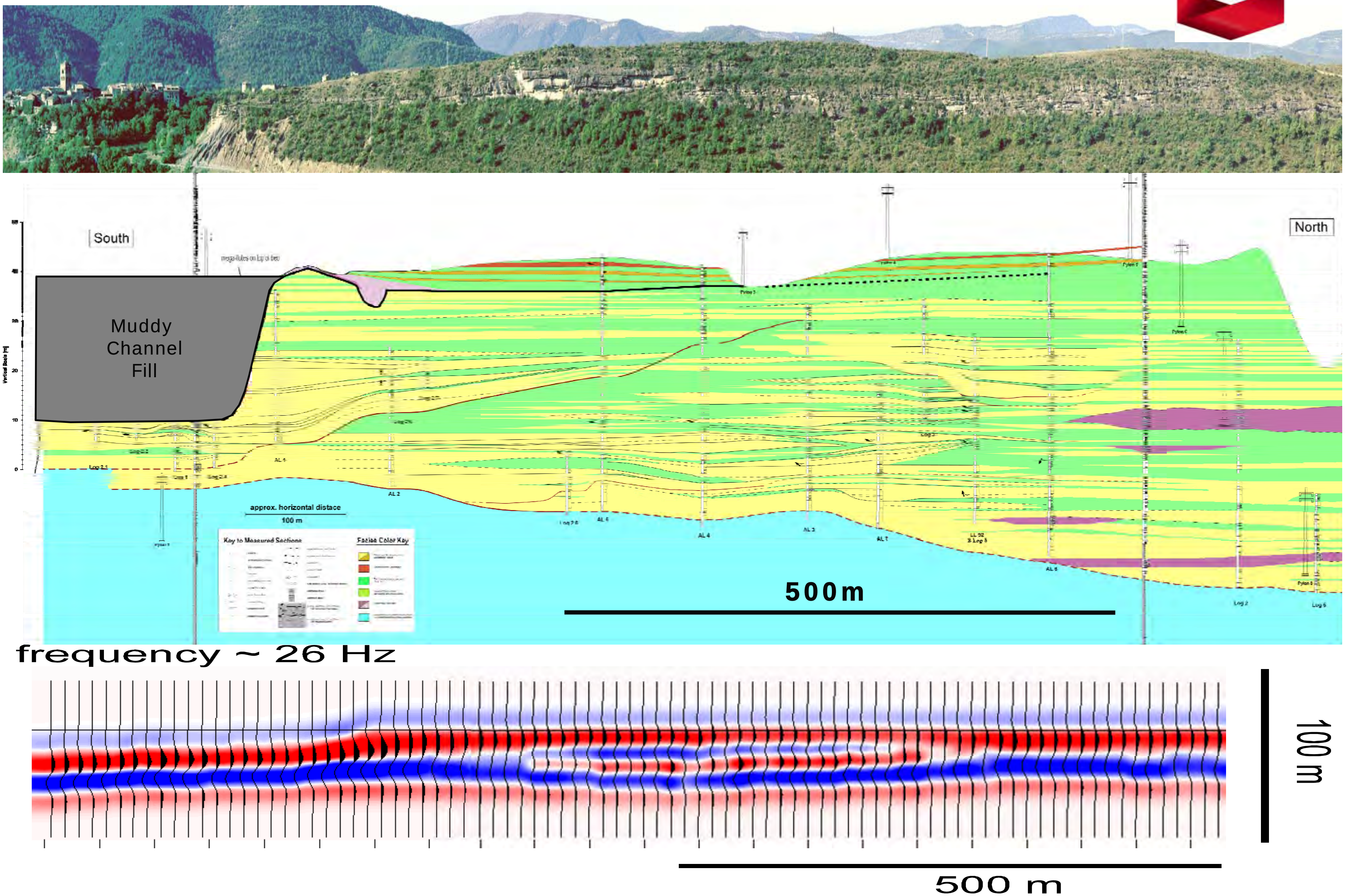


Clark (1994) & after Mutti *et al.* (1989)

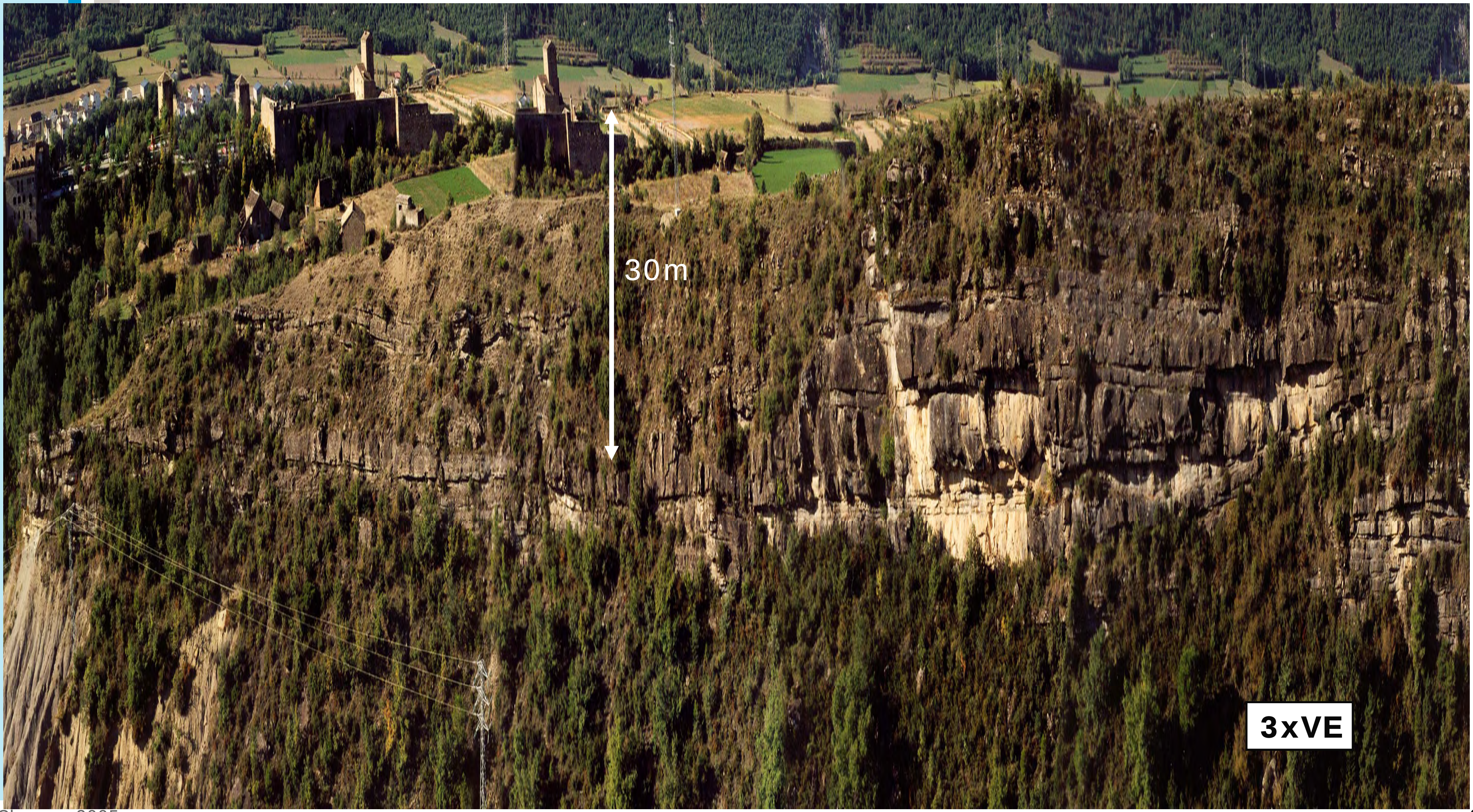
Shelf to Slope Cross Section



Ainsa II Stratigraphic Channel Hierarchy

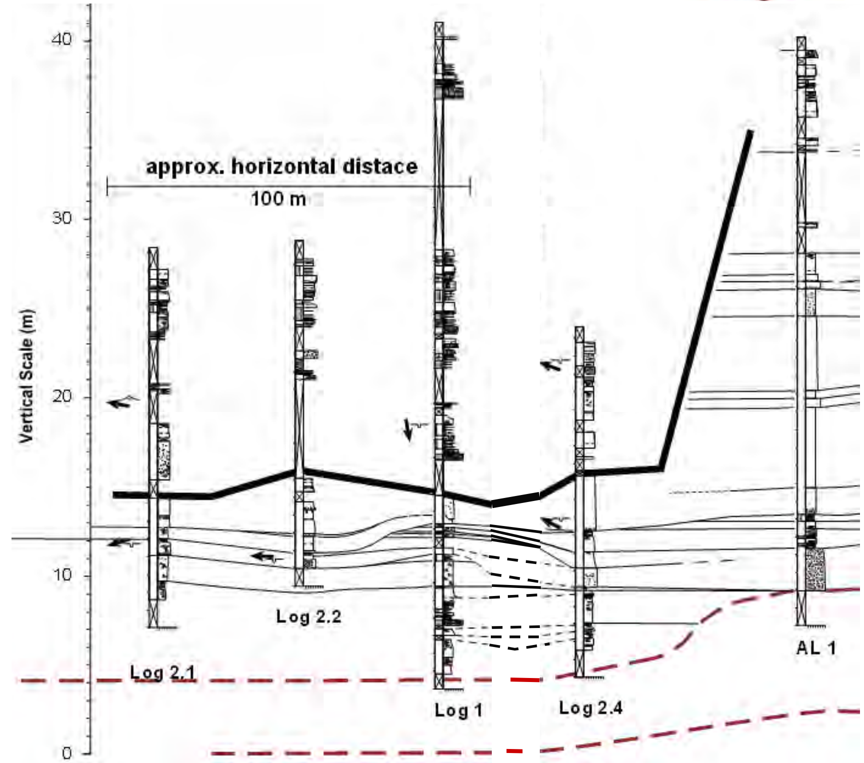



100m


30m
3xVE

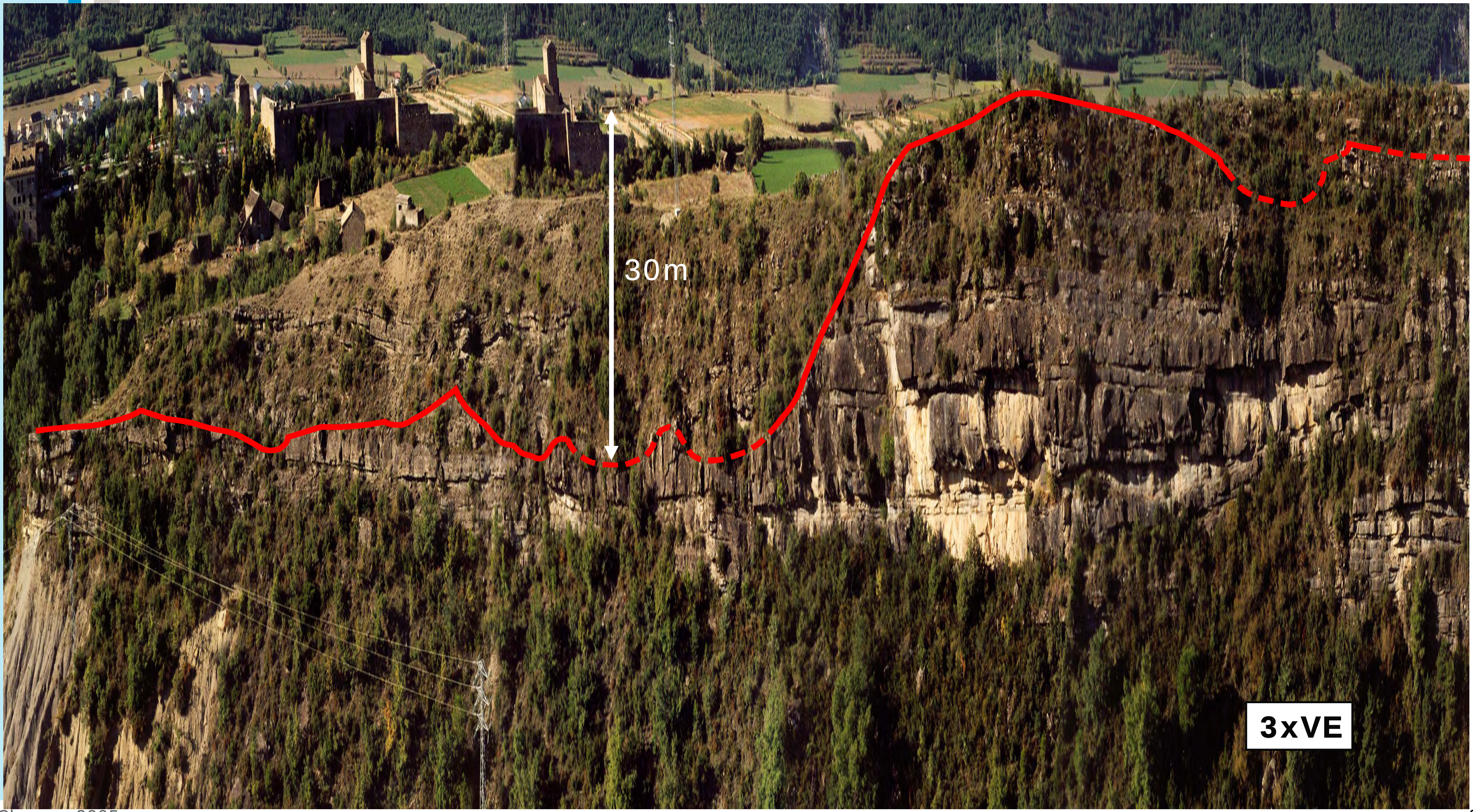
“Muddy Channel” Interpretation

- Erosional channel with muddier fill (Clark 1994)
  - But how to maintain steep sandy cut-bank?
- Slide/slump
  - Channel sands slumped downdip – replaced by muddier levee/overbank facies
- Debris flow channel
  - Ainsa cores
  - Falivene et al. 2006



Erosional Scours

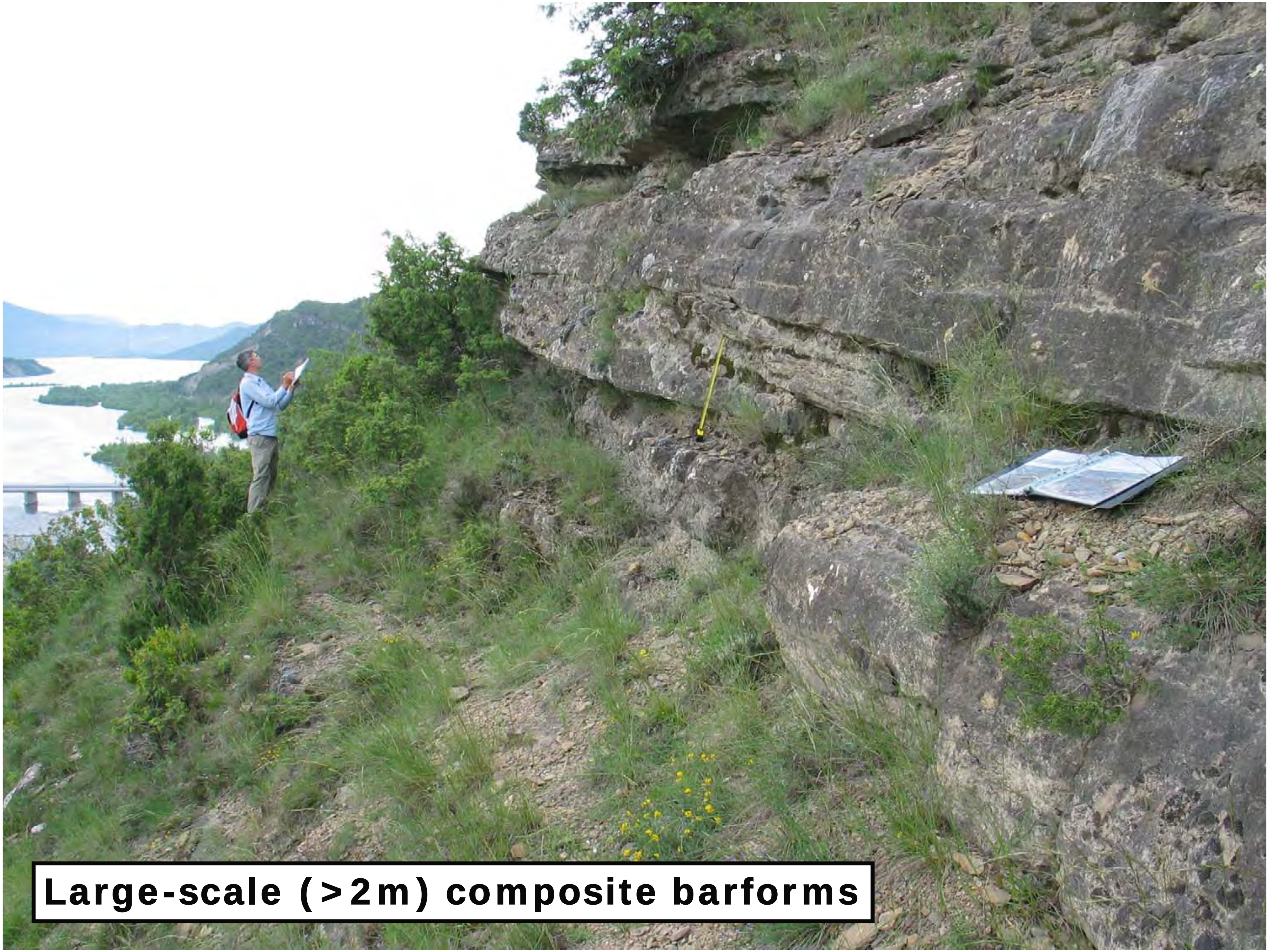

100m


30m
3xVE

Sandy Muddy Debrite

Muddy Sandy Debrite

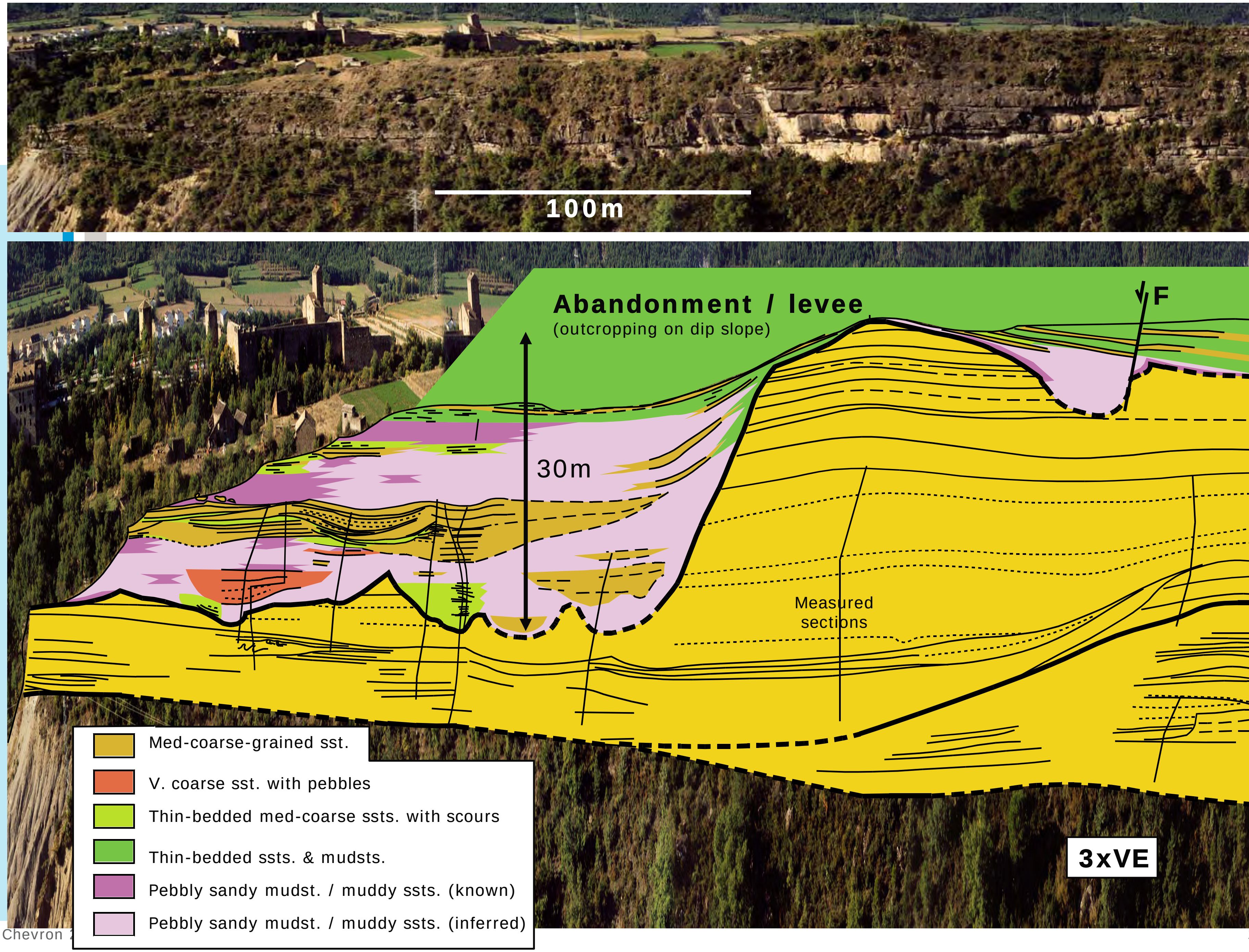
Poorly sorted Pebbly Sandstone (R3):
Imbricated pebbles => Bedload transportation

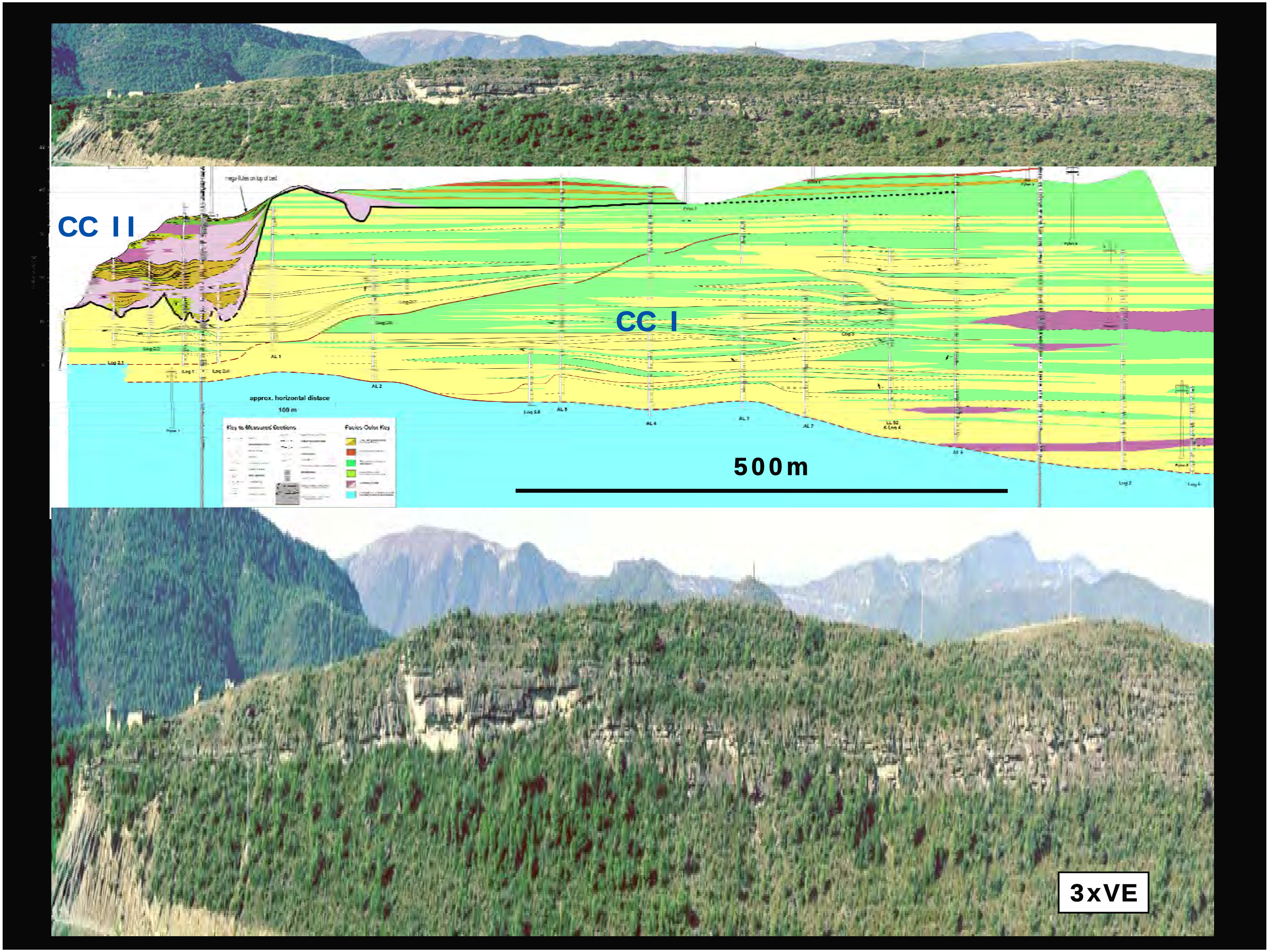

Large-scale (>2m) composite barforms


Scoured Thin-bedded Facies


Scoured Thin-bedded Facies


100m
30m
3xVE


100m
Abandonment / levee
(outcropping on dip slope)
F
30m
Measured sections
Med-coarse-grained sst.
V. coarse sst. with pebbles
Thin-bedded med-coarse ssts. with scours
Thin-bedded ssts. & mudsts.
Pebbly sandy mudst. / muddy ssts. (known)
Pebbly sandy mudst. / muddy ssts. (inferred)
3xVE

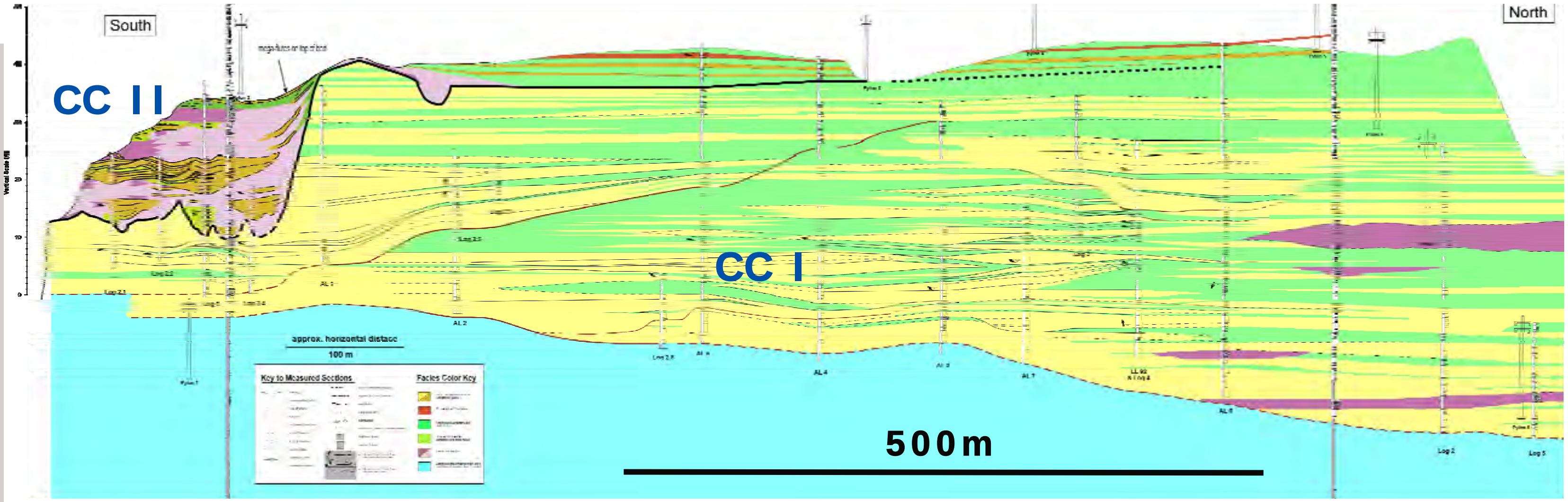

CC II
mega-flutes on top of bed
CC I
approx. horizontal distace
100 m
500m
3xVE

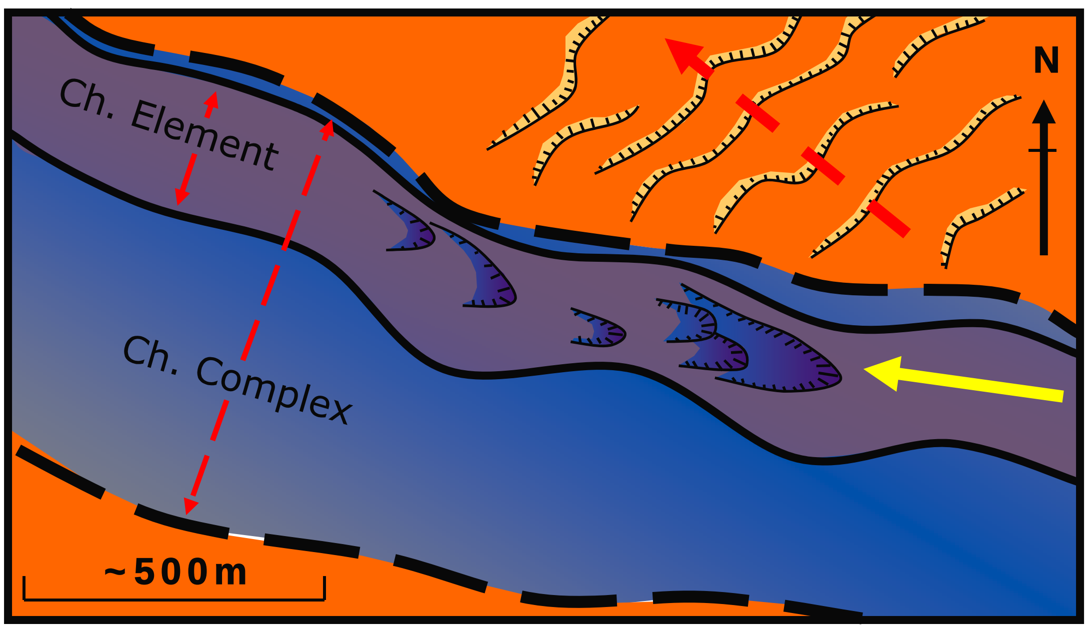
Cross-Bedded Coarse Sands


Thinning- & Fining-up Package


15 CM
5 CM
Slumped Thin-Beds

Paleo-Sea-floor Interpretation

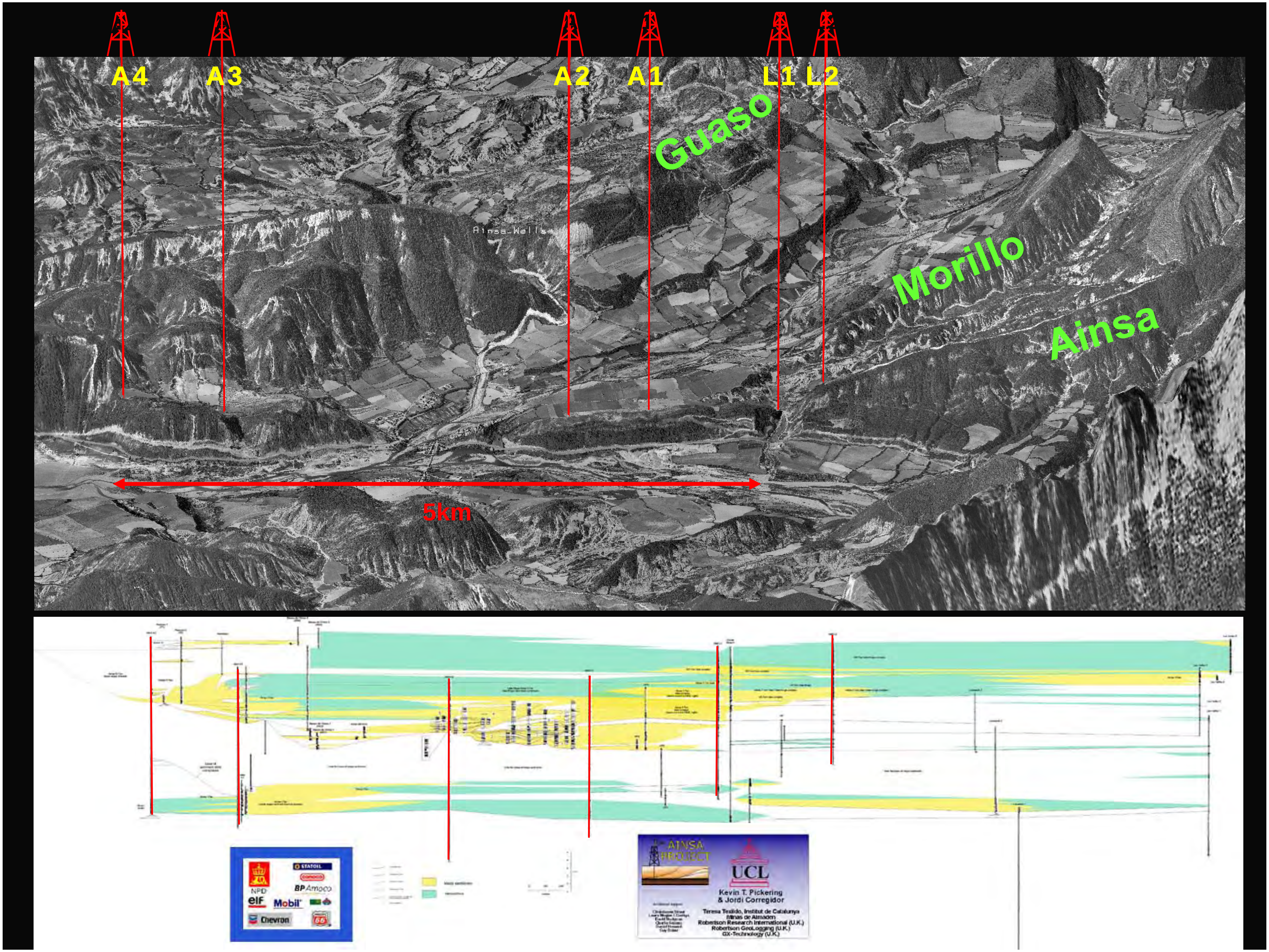




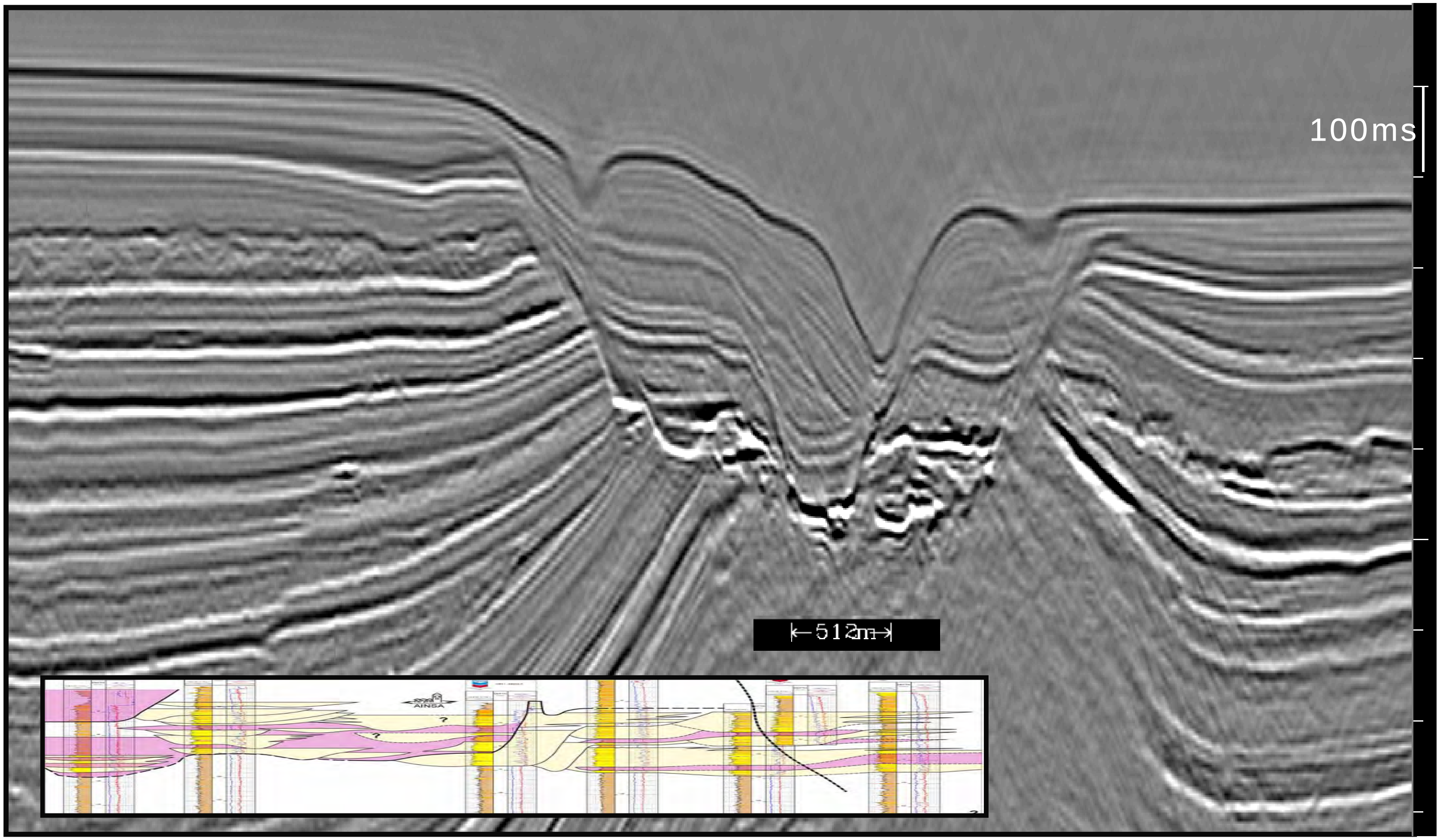
310° Mean P.C. in overbank

280° Mean P.C. in channel

Initiation of channel complex "Bypass Phase"


A4
A3
A2
A1
L1
L2
Guaso
Morillo
Ainsa
Ainsa_Wells
5km
AINSA PROJECT
UCL
Kevin T. Pickering
& Jordi Corregidor
Teresa Teixidó, Institut de Catalunya
Minas de Almaden
Robertson Research International (U.K.)
Robertson GeoLogging (U.K.)
GX-Technology (U.K.)
NPD
STATOIL
BP Amoco
Mobil
Chevron

Comparison with Seismic Data



Conclusions: Bypass Facies & Processes

- "Muddy Channel" interpreted to be complex-scale bypass facies association:
  - Composite erosional surface
  - Scoured thin-bedded facies
  - Debrites
  - Coarse-grained channels with bars
  - Aggradational levee with dunes (at base), fining-up sequence & localized slumps
- Debrites can be associated with bypass facies but not the process:
  - Sluggish flows infilling channels

Conclusions: Stratigraphic Controls

- Large scale erosional surfaces initiate channel complexes
- But what controls bypass?
  1. External cyclic forcing (allogenic)
  2. Autocyclic response of deepwater systems to bathymetry
- Supporting evidence:
  - Structurally active basin with syndepositional structures
    → fill & spill processes should be expected
  - Channel complexes appear to have gradual abandonments
    → autocyclic waxing-waning flow cycles