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Seismic architecture and morphology of Neogenic sediment waves and drift, offshore West Africa

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Scope of work

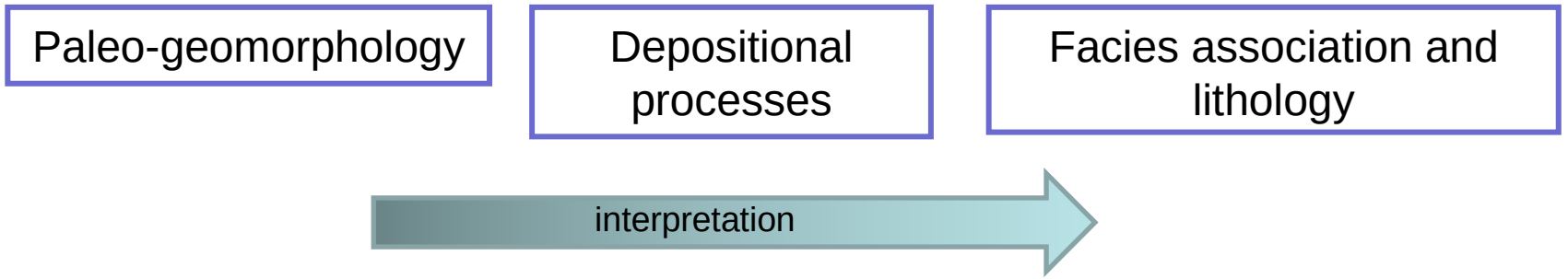
DATASET: 3D seismic data from West African margin.

METHODOLOGIES: seismic stratigraphy, seismic geomorphology.

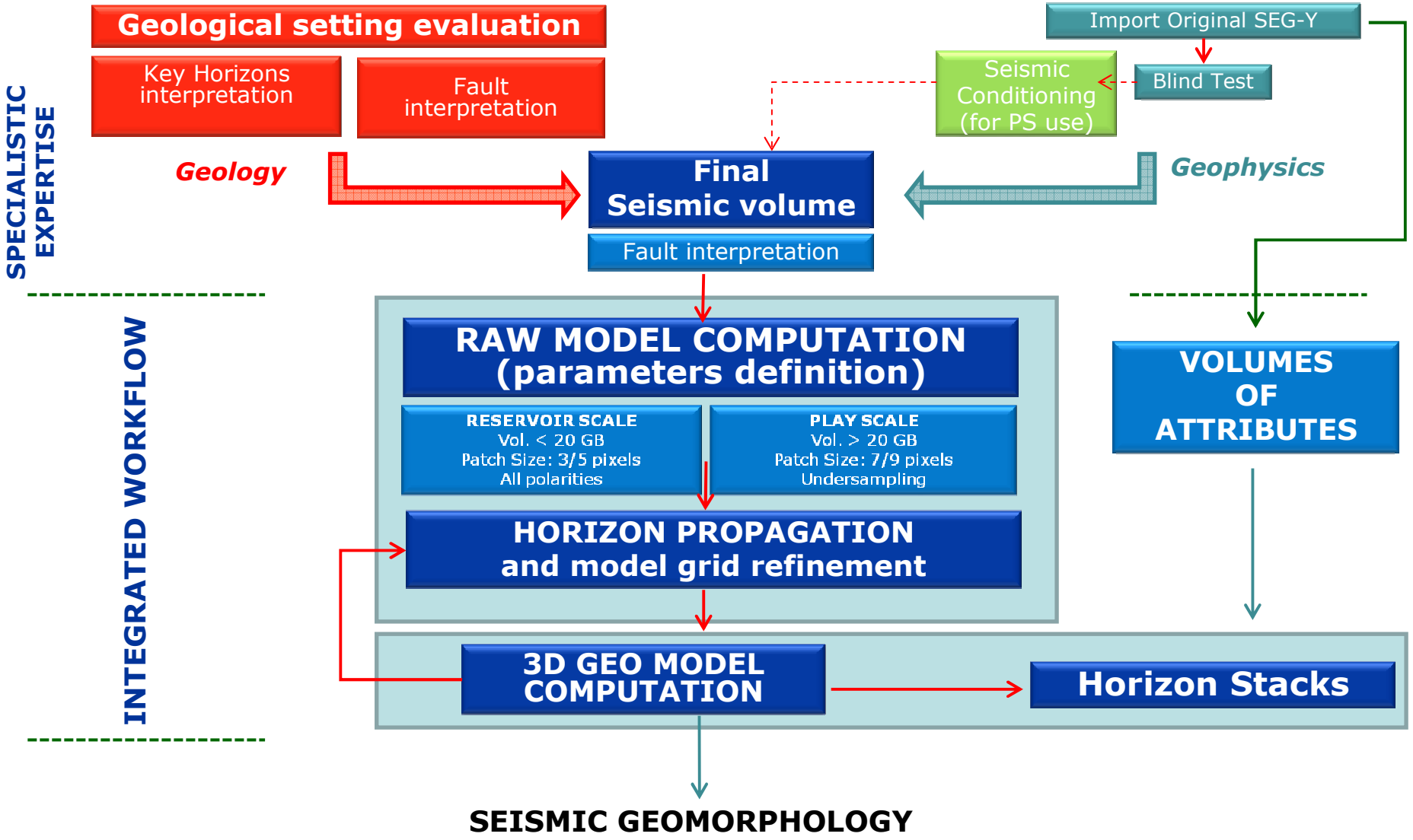
Each depositional element displays a unique morphology and seismic expression. High quality 3D dataset can be used as analogue for other cases.

- RATIONALE:

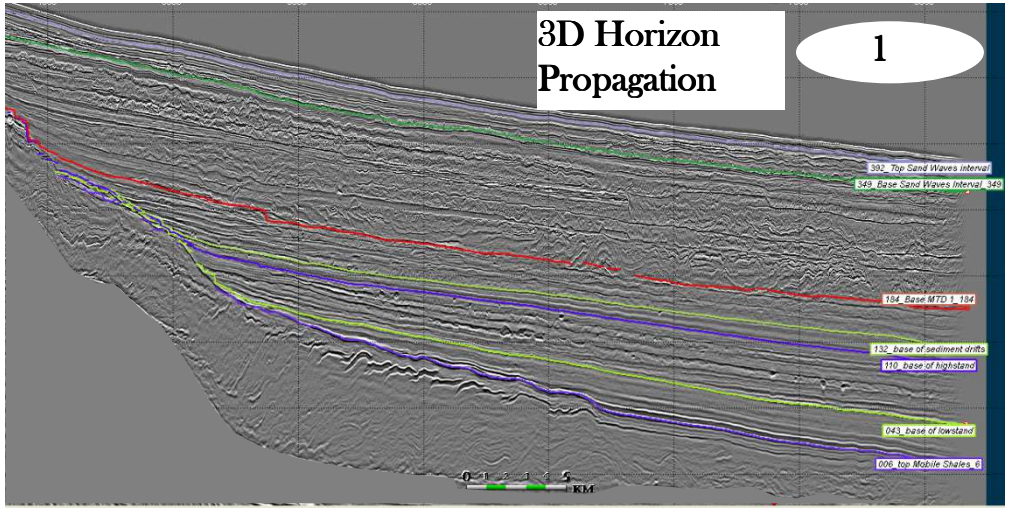
  - Analysis of 3D seismic data (PaleoScan) to identify the main sedimentary architectures and features.
  - Inference of depositional processes where appropriate.
  - Qualitative evaluation of the possible relations between different kinds of deposits.

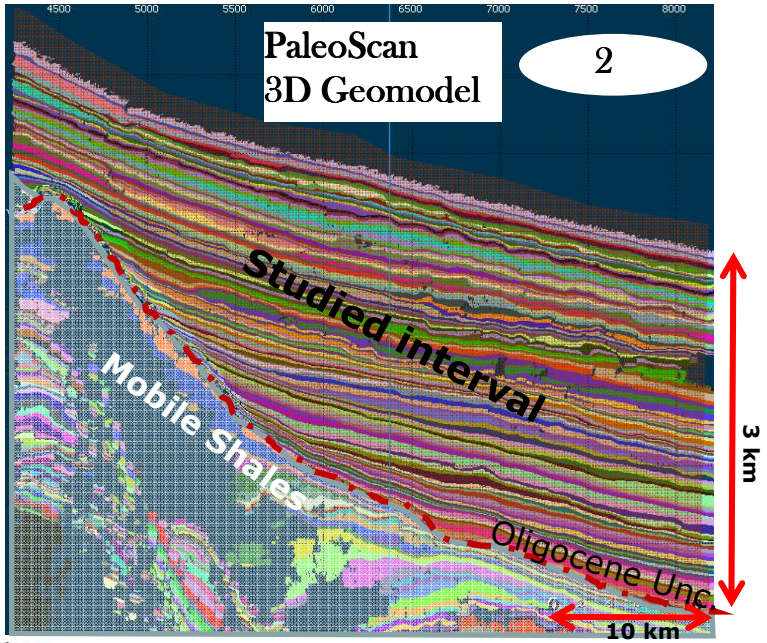


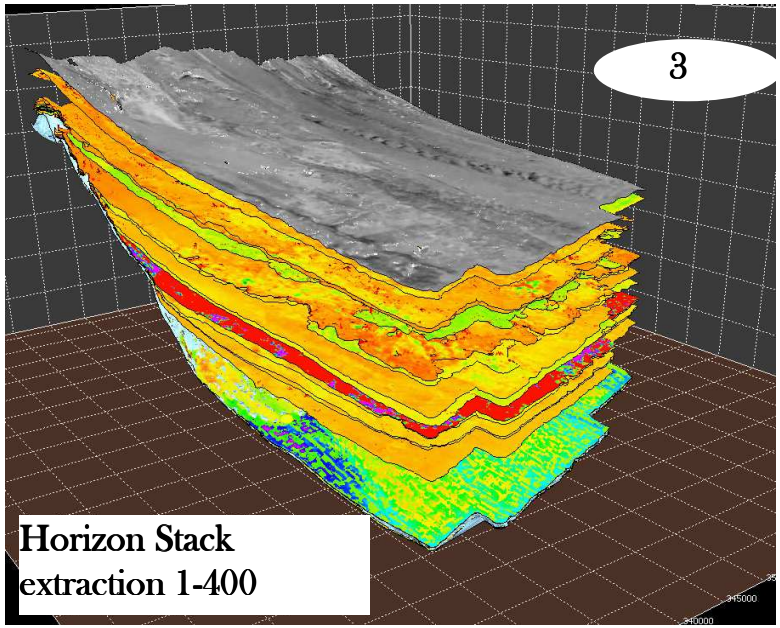
3D Interpretative workflow with PaleoScan



Interpretative workflow with PaleoScan (2)







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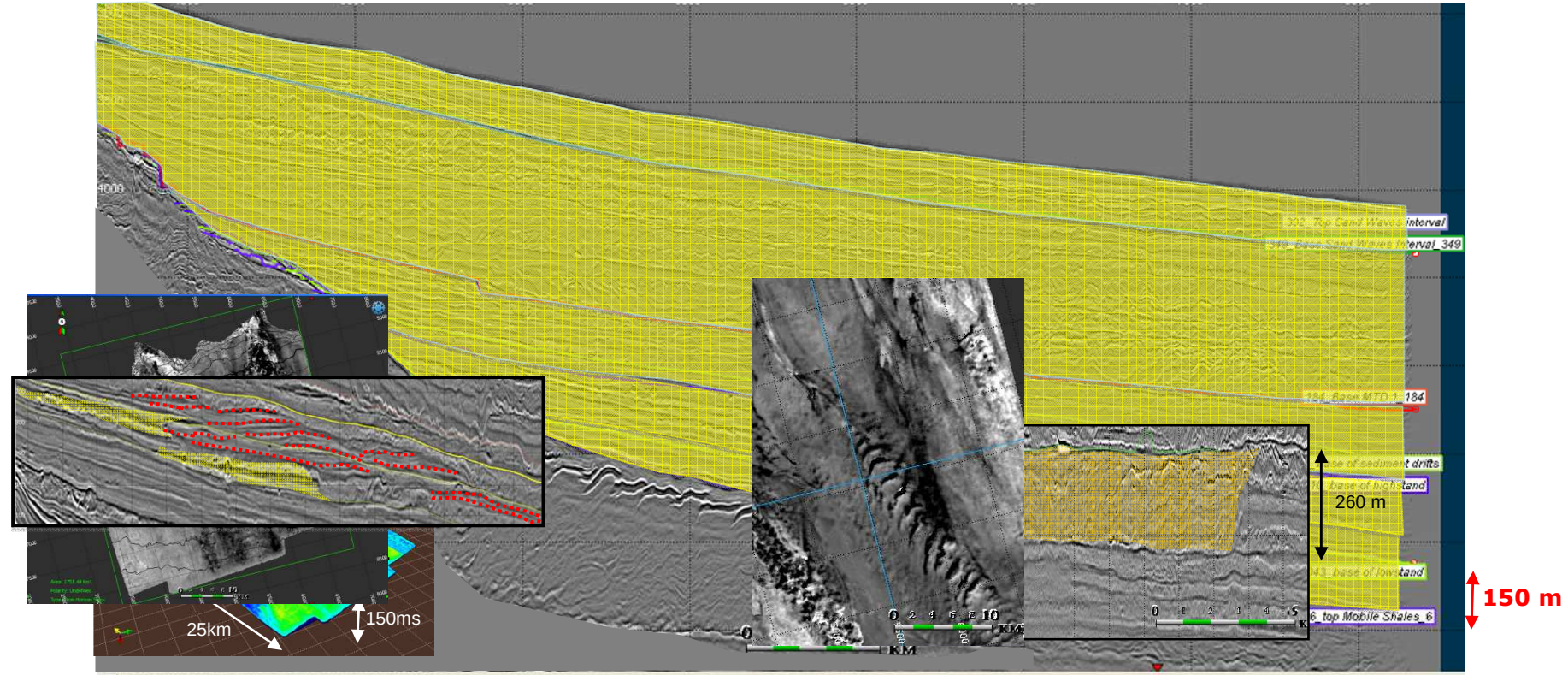
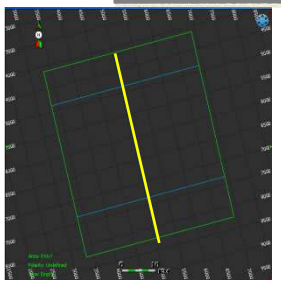
Geological Framework

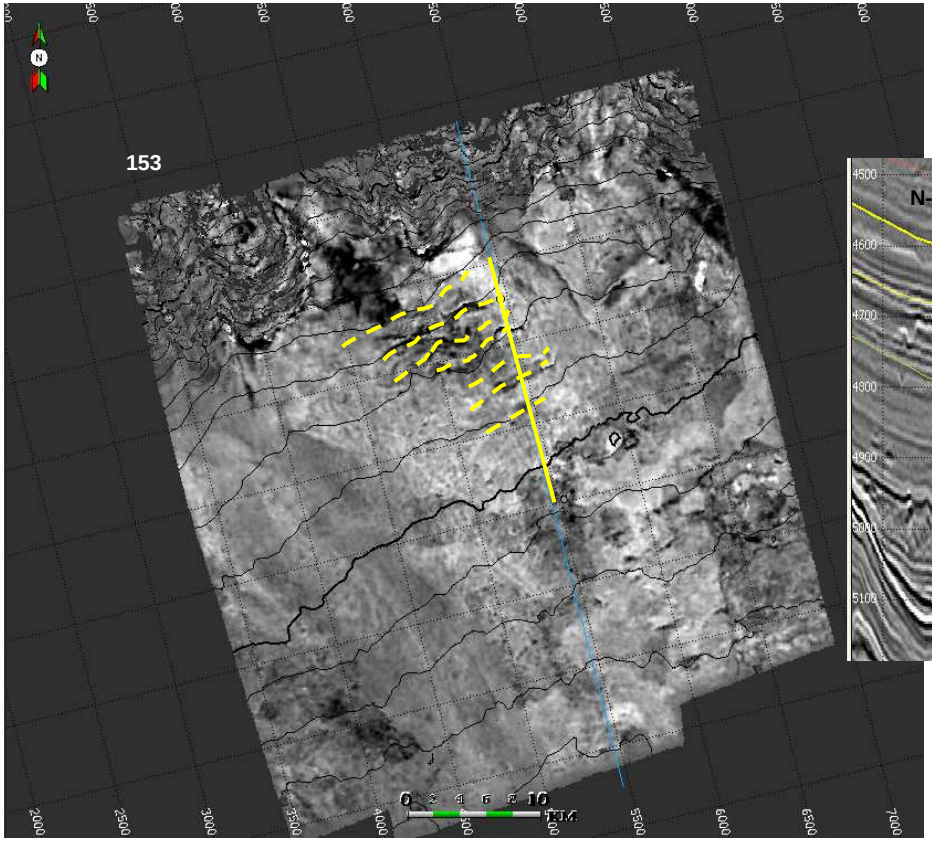
Regional seismic facies analysis integrated with a PaleoScan Geomodel on a 3D seismic survey.

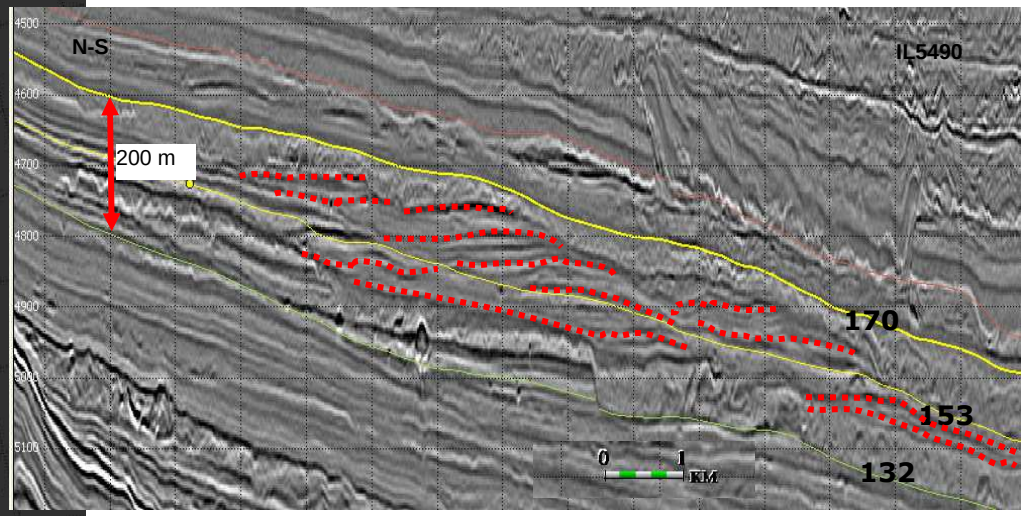




N°	Interval	Inferred Tracts	Features
5	304-400	High-stand	MTDs and sediment waves
4	184-304	Low-stand	MTD's, Channels
3	110-184	High-stand	Mud deposits and sediment waves
2	74-110	Transgressive	Debris flows, Channel lobes
1	0-74	Low-stand	MTD's, Basin floor fans, Channel lobes

Interval 132-170 (Horizon 153): Sediment waves



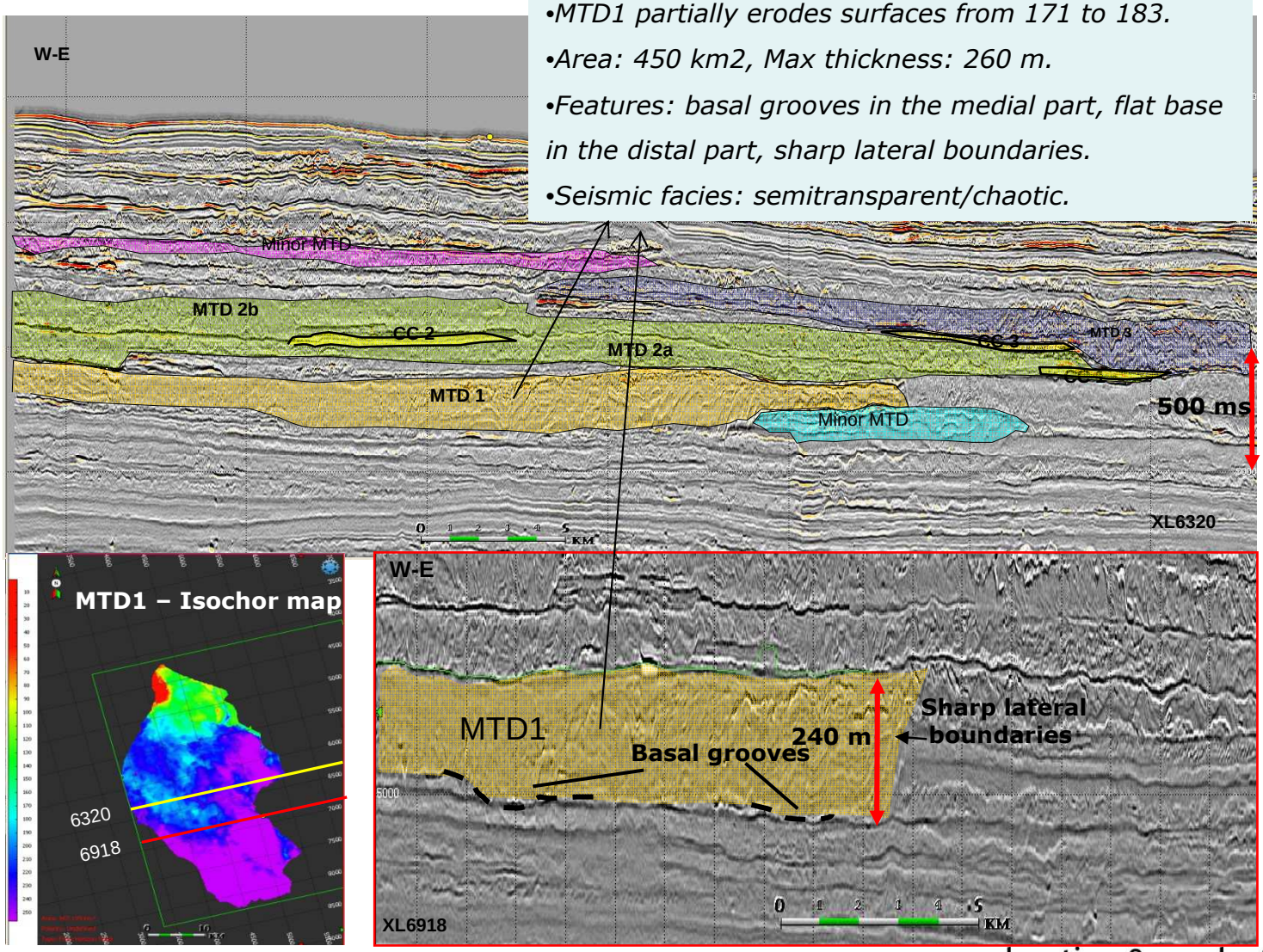


In this interval, bottom currents played a major role in reworking and redistributing sediment derived from basin margin.

- *Sediment waves.*
- *Thickness of individual series: 150 ms – 150 m.*
- *Plan view geometry: north migrating drifts, subparallel to the shelf edge..*
- *Seismic facies: wavy medium amplitude convex upward reflectors.*

Interval 184-304: Mass Transport Deposits (MTDs)

- *MTD1 partially erodes surfaces from 171 to 183.*
- *Area: 450 km2, Max thickness: 260 m.*
- *Features: basal grooves in the medial part, flat base in the distal part, sharp lateral boundaries.*
- *Seismic facies: semitransparent/chaotic.*



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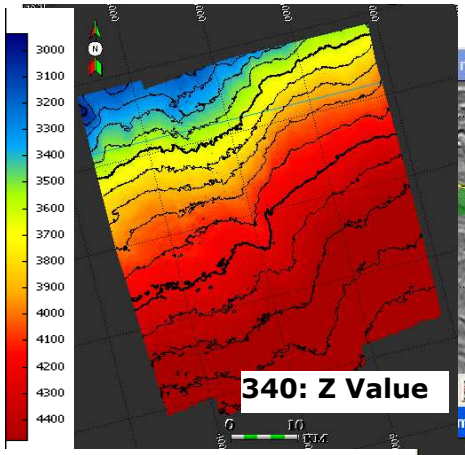
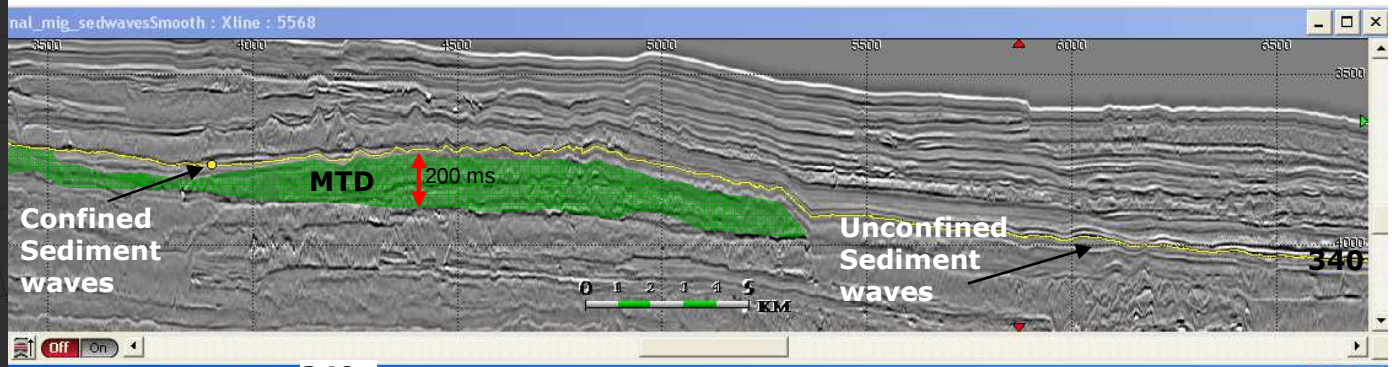
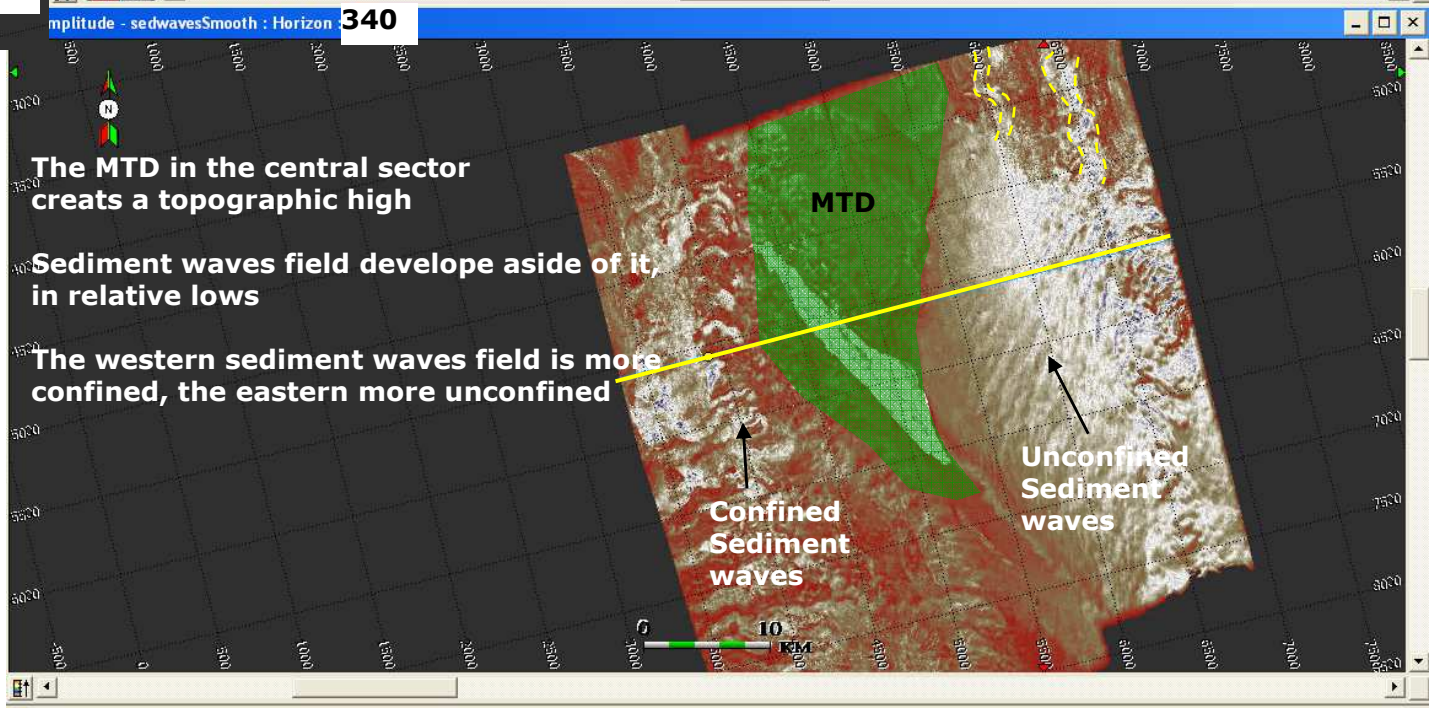
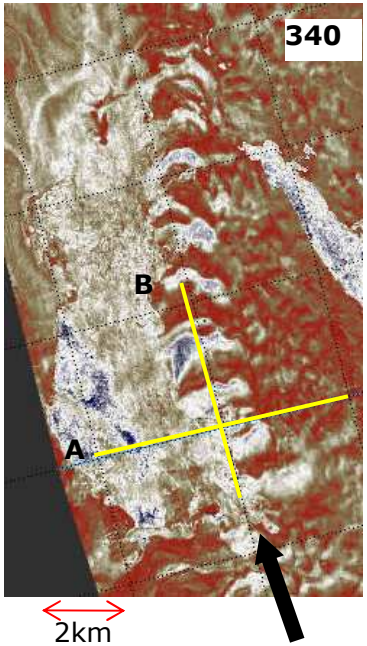
Gravity flow deposits vs bottom current reworking: HS 340

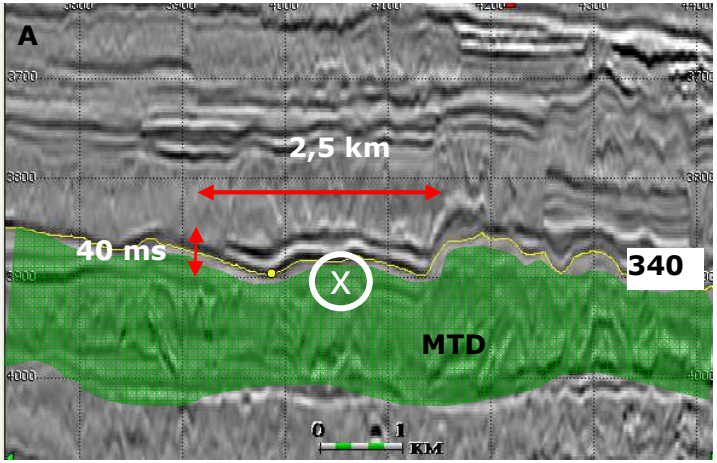


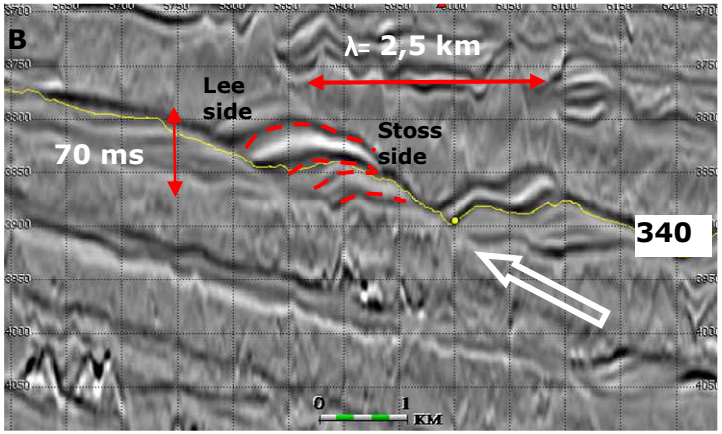




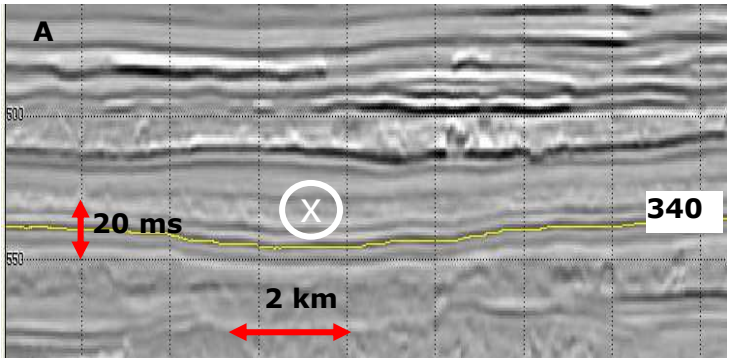
Morphometry of confined/unconfined sed waves

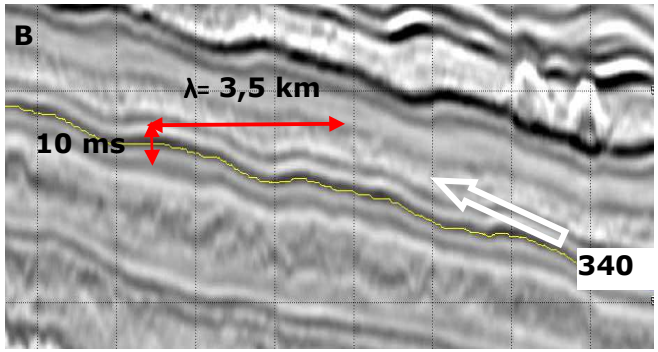


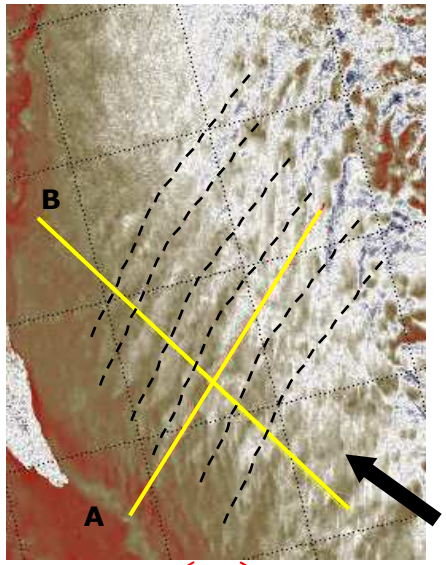




Lateral confinement → Flow accelerating upslope → Climbing mega-dunes







Smooth pre-existing topography → Laterally homogeneous flow → Smooth aggrading sediment waves

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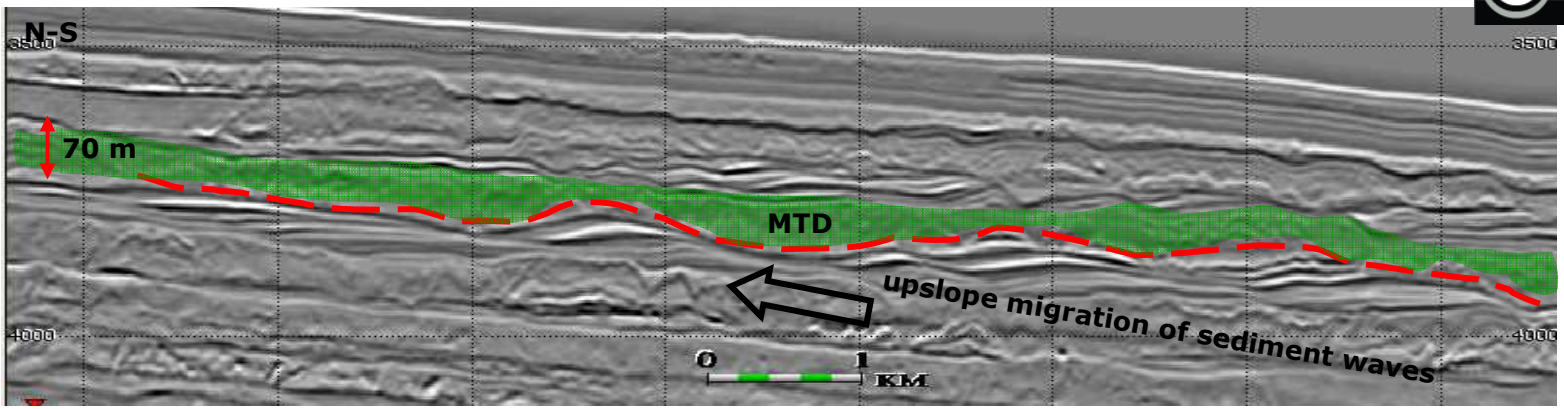
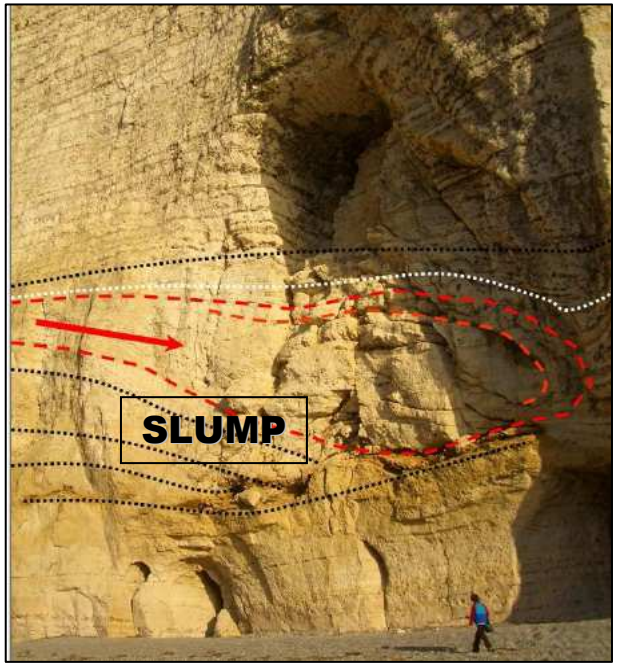
Relation MTDs-climbing dunes





Chalk Group, Etretat Cliffs, N France
(courtesy of Gennaro)

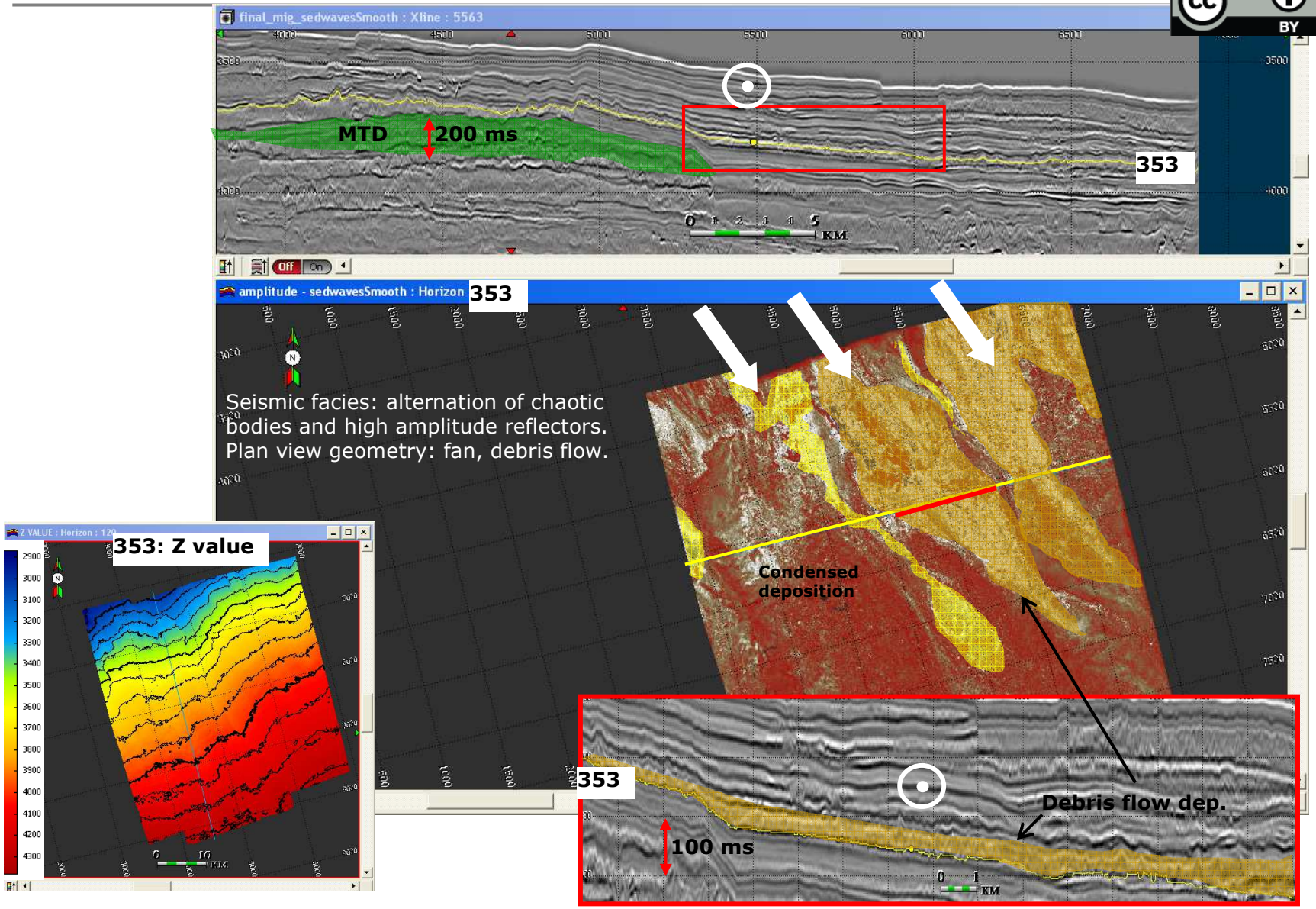
How the basin fill?

•Bottom currents accelerate and rework deposits preferentially in lows left by MTDs

•MTDs (slumps) preferentially fill the lows left by Sediment Waves field, preserving them from erosion.

RECIPROCAL COMPENSATION

Gravity flow deposits vs bottom current reworking: HS 353



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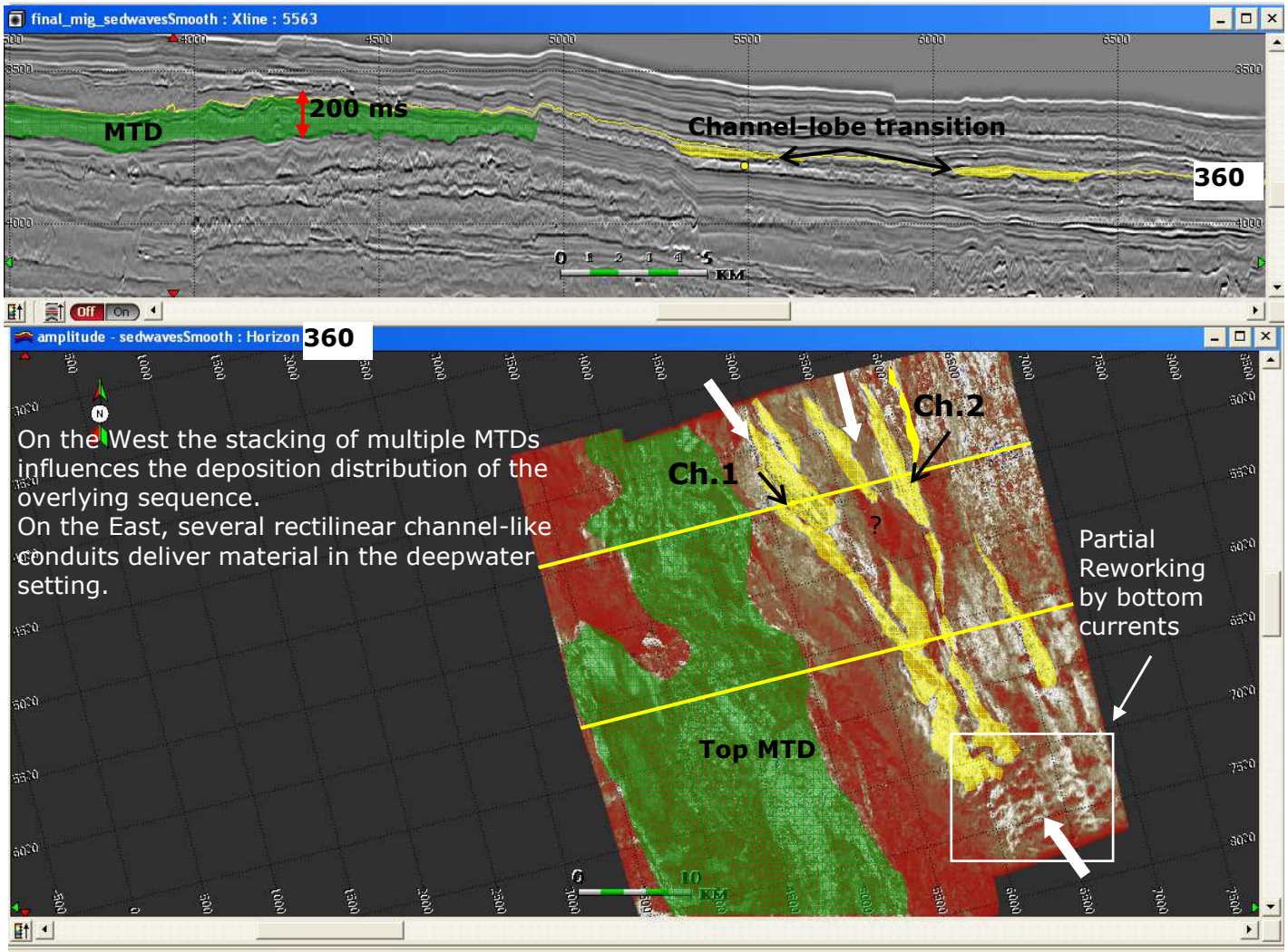
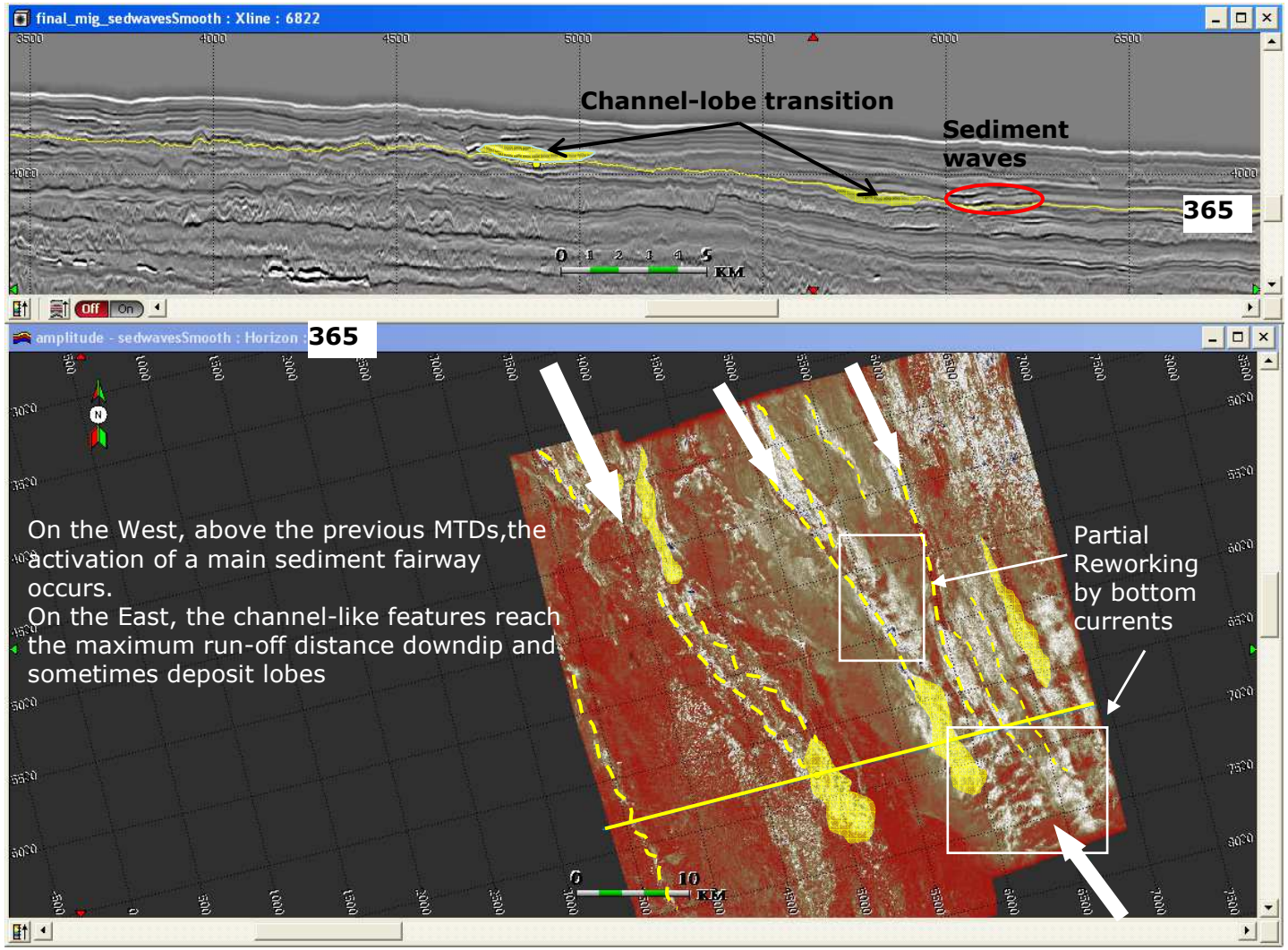
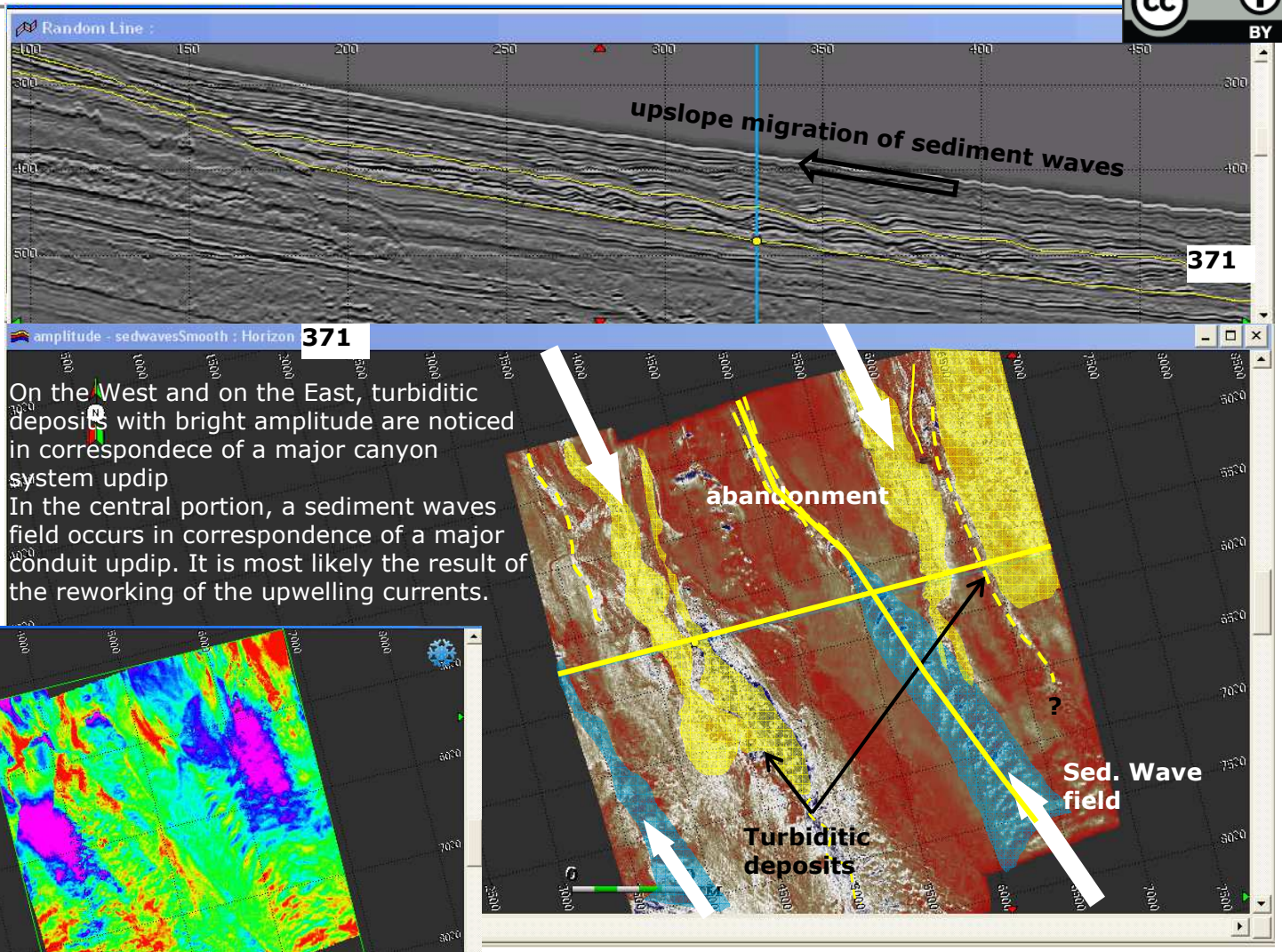
Gravity flow deposits vs bottom current reworking: HS 360



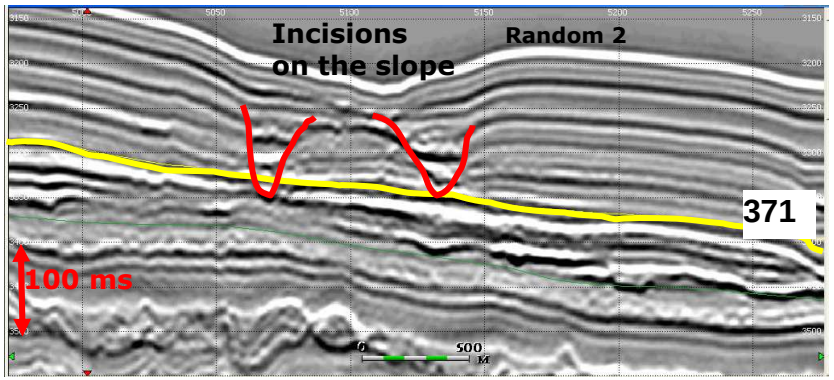
Gravity flow deposits vs bottom current reworking: HS 365

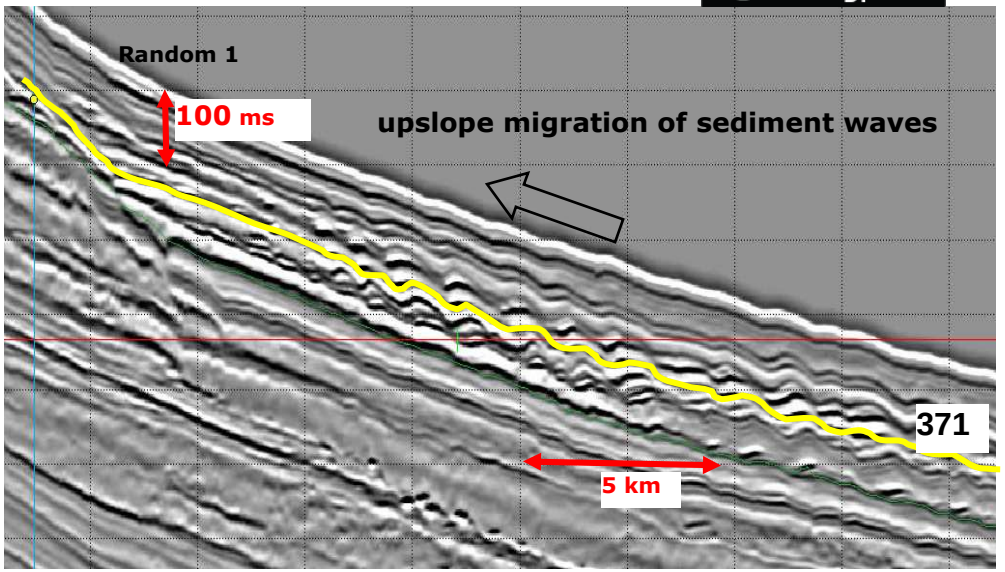


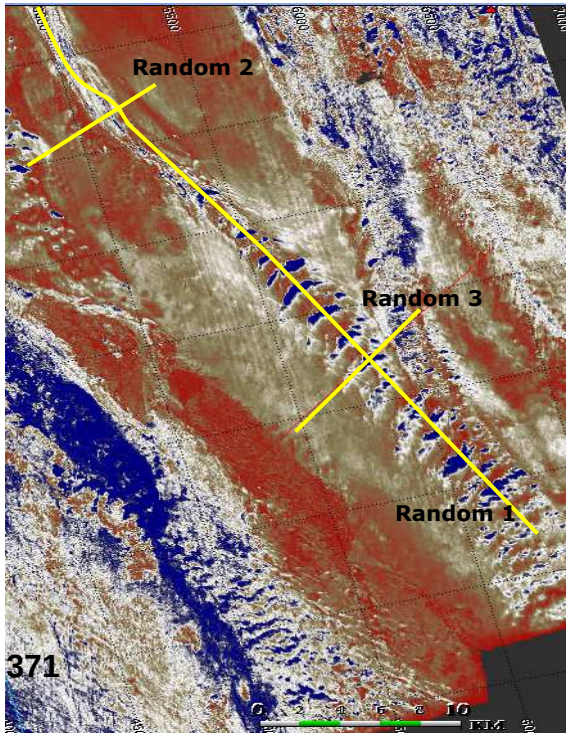
Gravity flow deposits vs bottom current reworking: HS 371

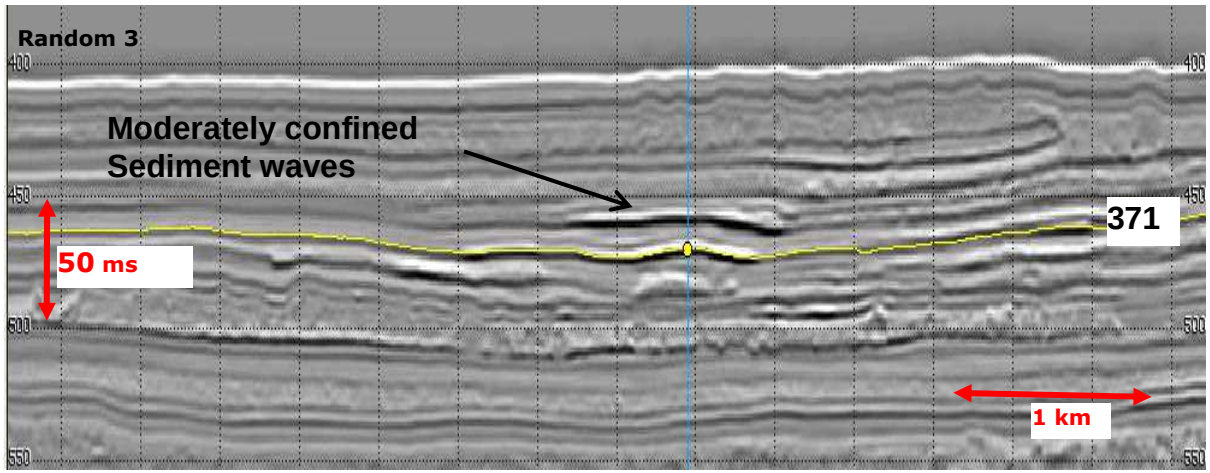


Sediment Waves

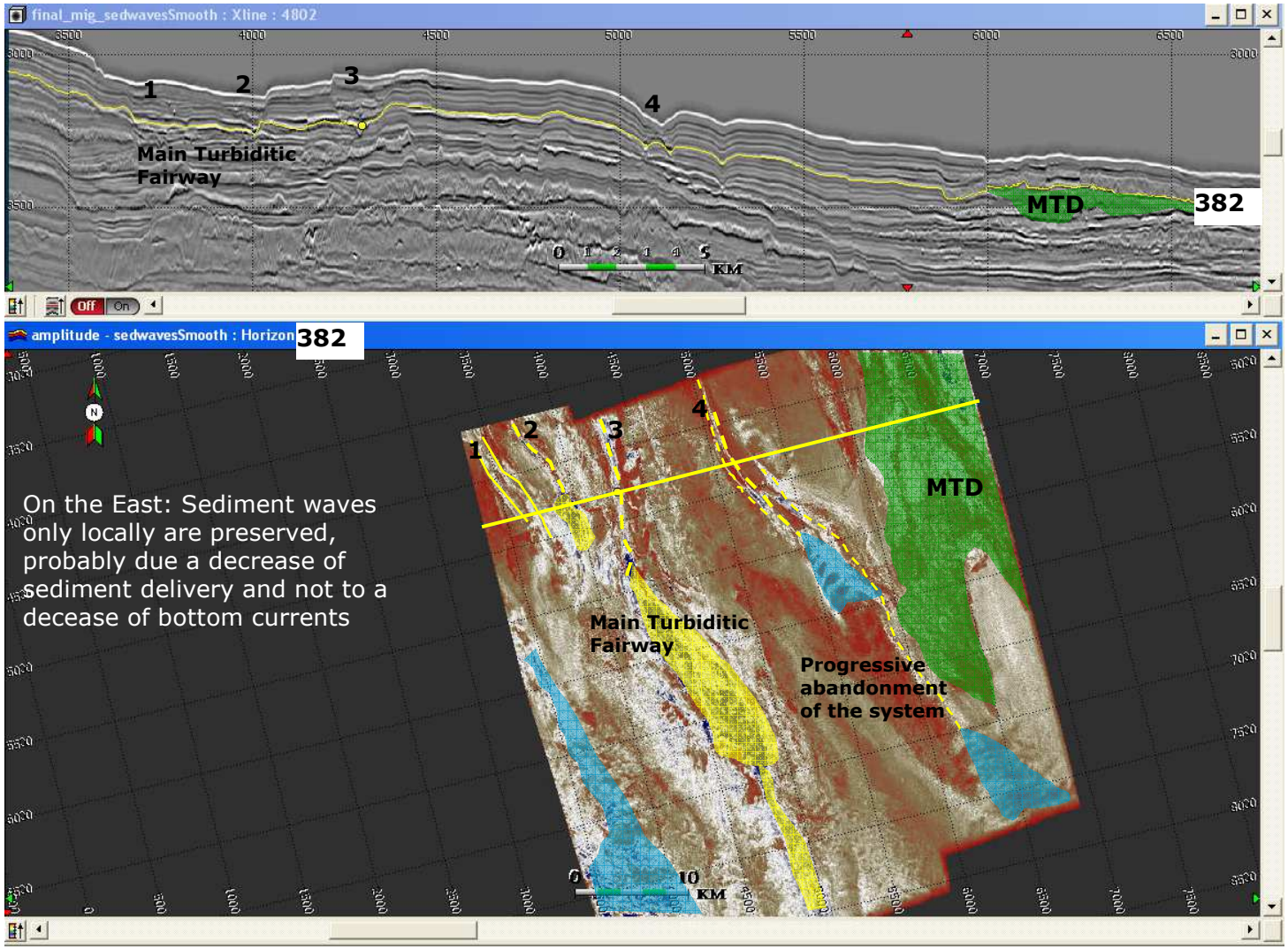




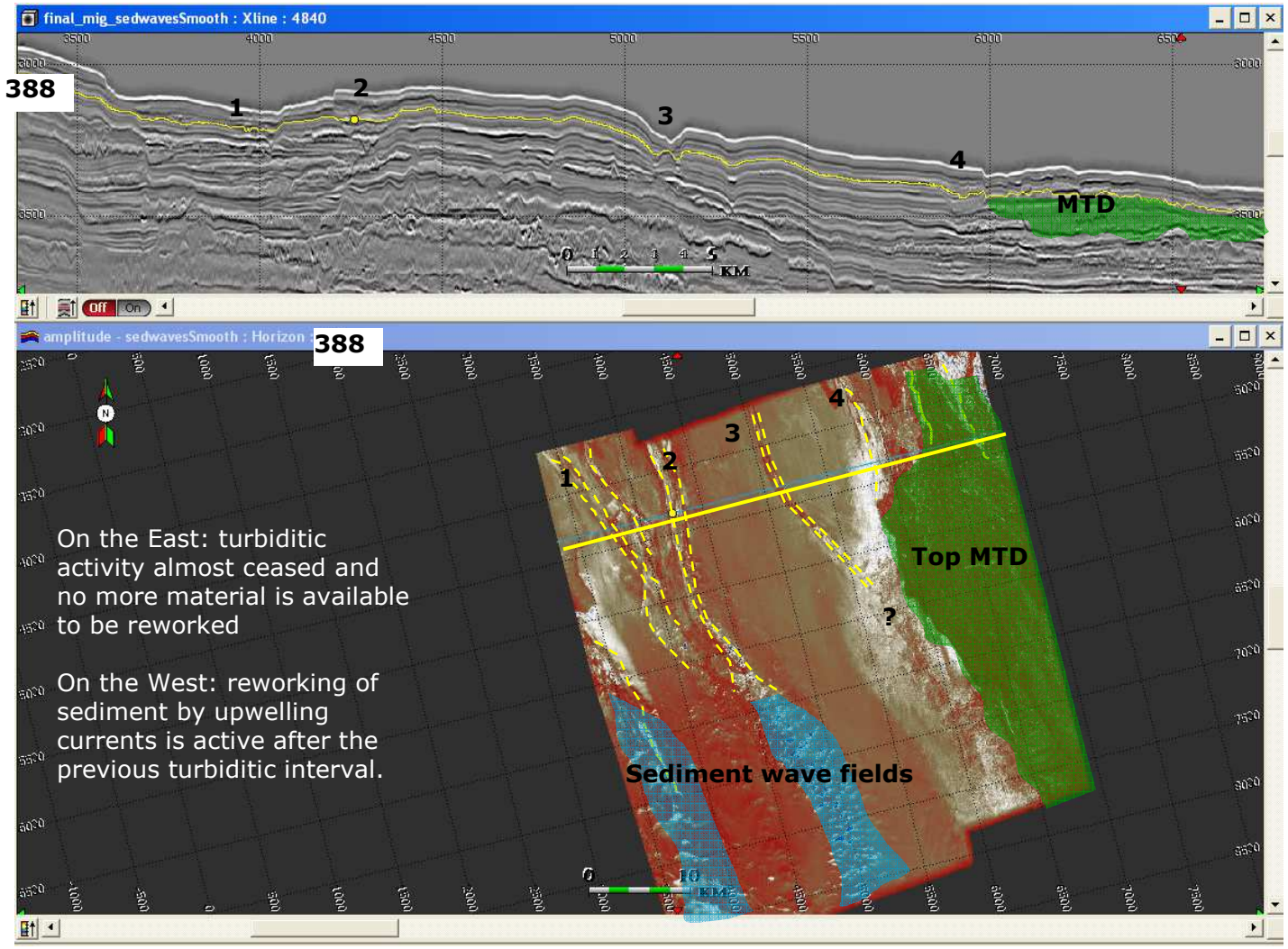




Gravity flow deposits vs bottom current reworking: HS 382



Gravity flow deposits vs bottom current reworking: HS 388



Upwelling Model – Example from Literature

References

•Oligocene to Holocene sediment drifts and bottom-currents on the slope of Gabon continental margin (West Africa): consequences for sedimentation and southeast Atlantic upwelling (Séranne et al., Sedimentary Geology, 2000).

•Mass transport-related stratal disruption within sedimentary mélanges: Examples from the northern Apennines (Italy) and south-central Pyrenees (Spain) (Ogata et al., tectonophysics, 2011)

•Seismic Geomorphology and Stratigraphy of Depositional Elements (Posamentier and Kolla, Journal of Sedimentary research, 2003)

• Deep_water Processes and Facies Models:Implications for Sandstone Petroleum Reservoirs (Shanmugam, 2006)

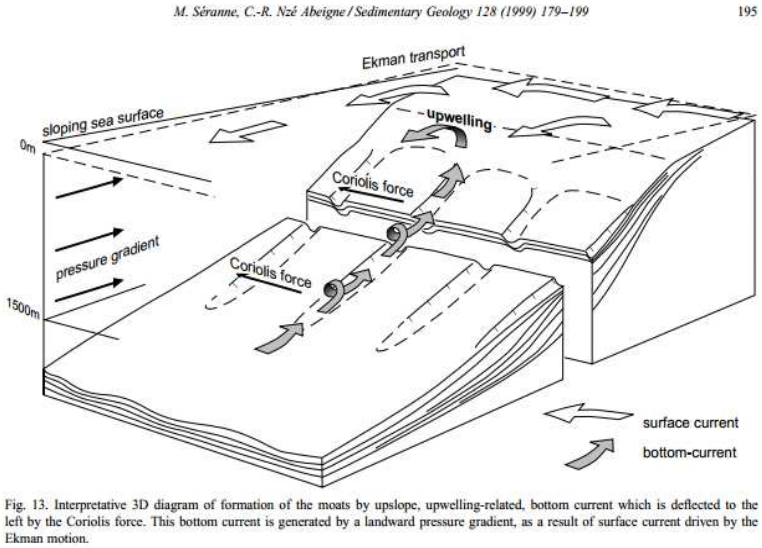


Fig. 13. Interpretative 3D diagram of formation of the moats by upslope, upwelling-related, bottom current which is deflected to the left by the Coriolis force. This bottom current is generated by a landward pressure gradient, as a result of surface current driven by the Ekman motion.

Example from Gabon

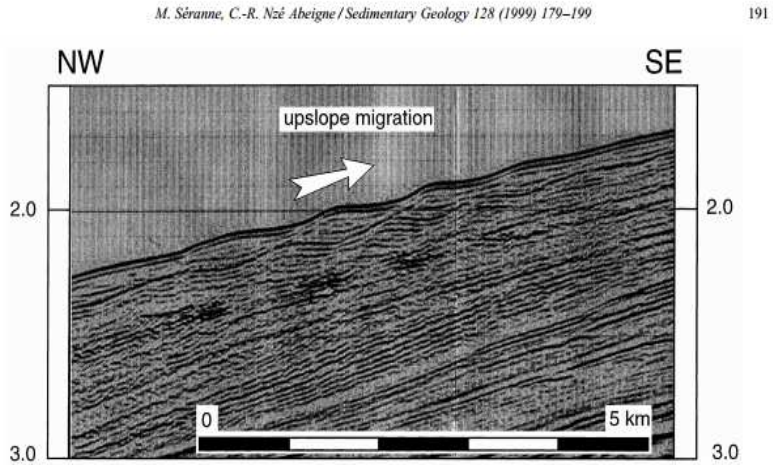
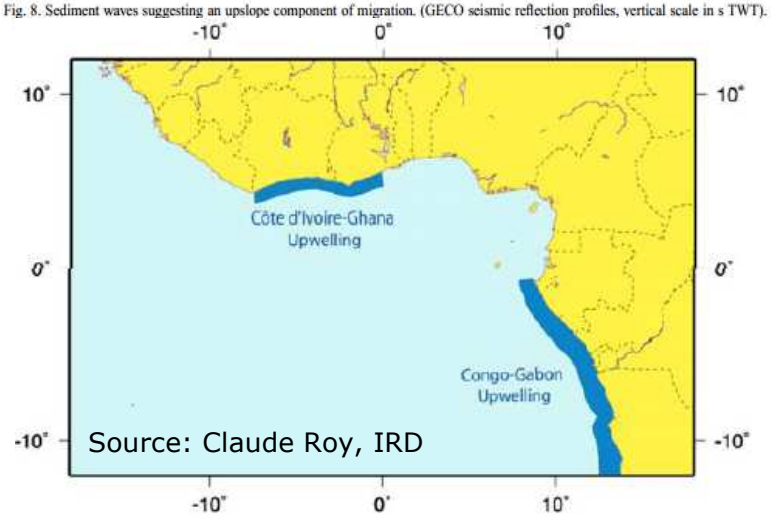


Fig. 8. Sediment waves suggesting an upslope component of migration. (GECO seismic reflection profiles, vertical scale in s TWT).



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Conclusions

- 3D seismic volume shows alternation of widespread gravitational remobilization and slumping with bottom current deposits.
- Bottom currents persist steady for the full time interval, flow upslope, are free of sediments (“clear water currents”, Bouma and Hollister, 1973) and transport sand primarily by traction.
- Turbidity currents are episodic events, they cannot exist without entrained sediment and are able to transport downslope fine sand and mud in suspension.
- This seismic volume provide general insight into the deep-water depositional elements, which can be extrapolated to more poorly resolved systems at greater depths.
- Benefits of 3D semi-authomatic interpretation – well resolved systems with a great safe of time.