A mixed contour current – turbidity system from the São Vicente Canyon, Gulf of Cadiz: depositional features and significance for submarine slope stability

Gulf of Cadiz, offshore Portugal

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SLATE
Submarine Landslides and their impact on European continental margins

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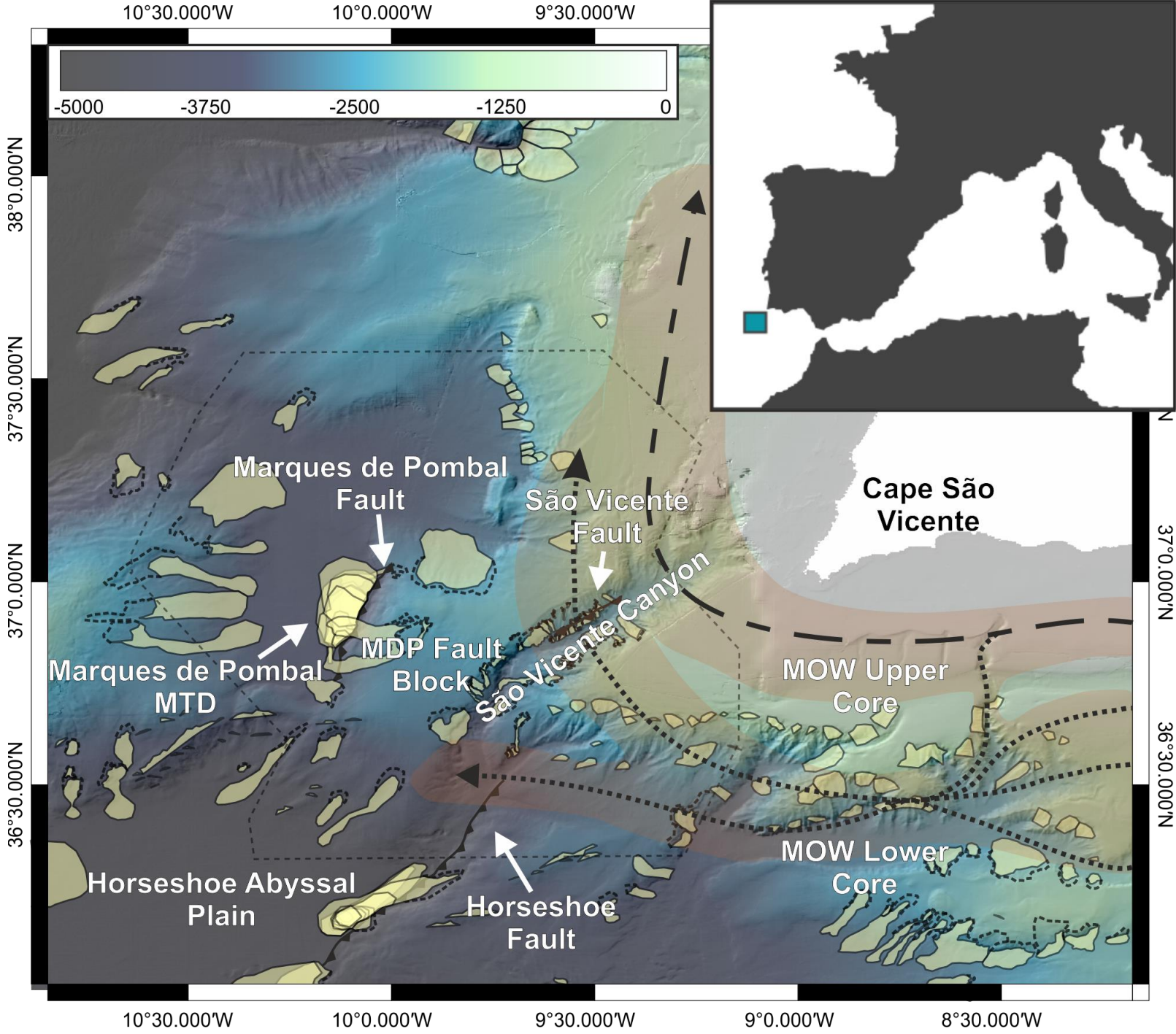
Area of interest

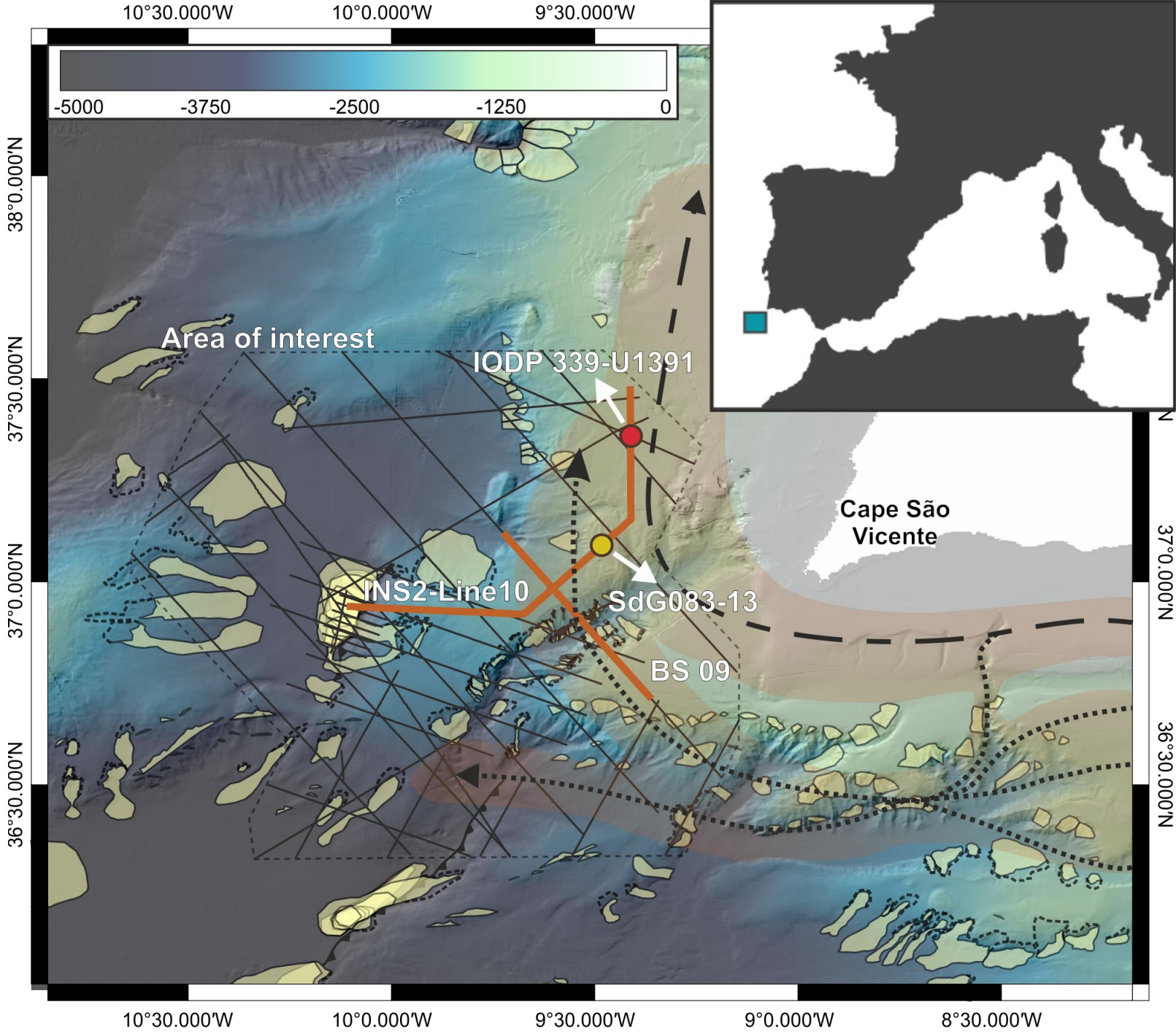
Alentejo Basin, Gulf of Cadiz

- Extensive contourite depositional system generated by the MOW;
- Several potentially tsunamigenic faults (Marques de Pombal Fault, Horseshoe Fault, São Vicente Fault, ...);
- Multiple mass transport deposits (MTDs) and scars;
- **São Vicente Canyon**:
  - Biggest canyon in the Gulf of Cadiz: <150 km long, 20 km wide);
  - Developed starting from the Pliocene by retrogressive erosion[(1)];



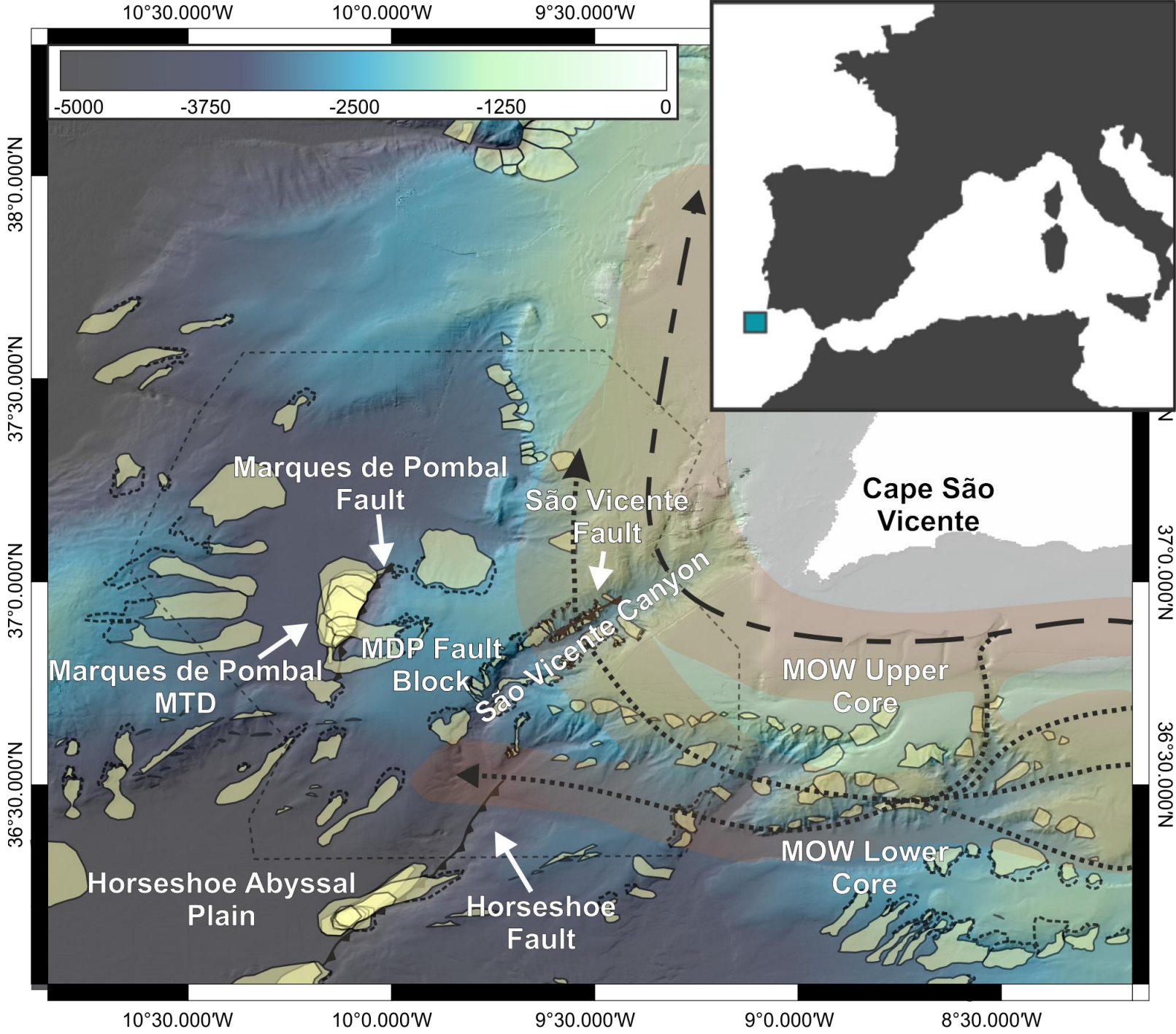
Available data:

- Swath-bathymetry;
- 35 MCS profiles;
- **IODP well 339-U1391**
  - Explored the contourite deposition in the northern sector of the Gulf of Cadiz;
  - Detected discontinuities, erosional surfaces and different grain size distributions due to different MOW hydrodynamic regimes[(2)];
- **INSIGHT-Leg2 (2019)**
  - INS2-Line10: MCS profile linking the IODP well 330-U1391 with the Marques de Pombal Plateau;
  - SdG083-13: Gravity core (230 cm)

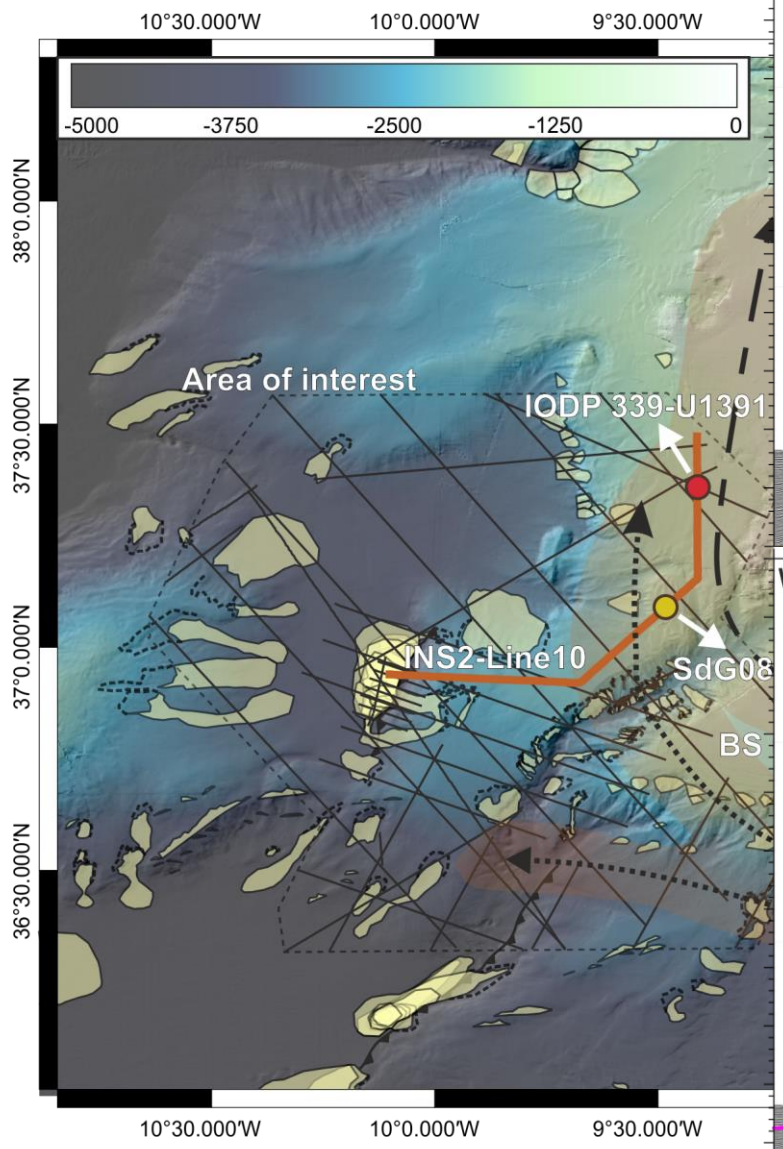


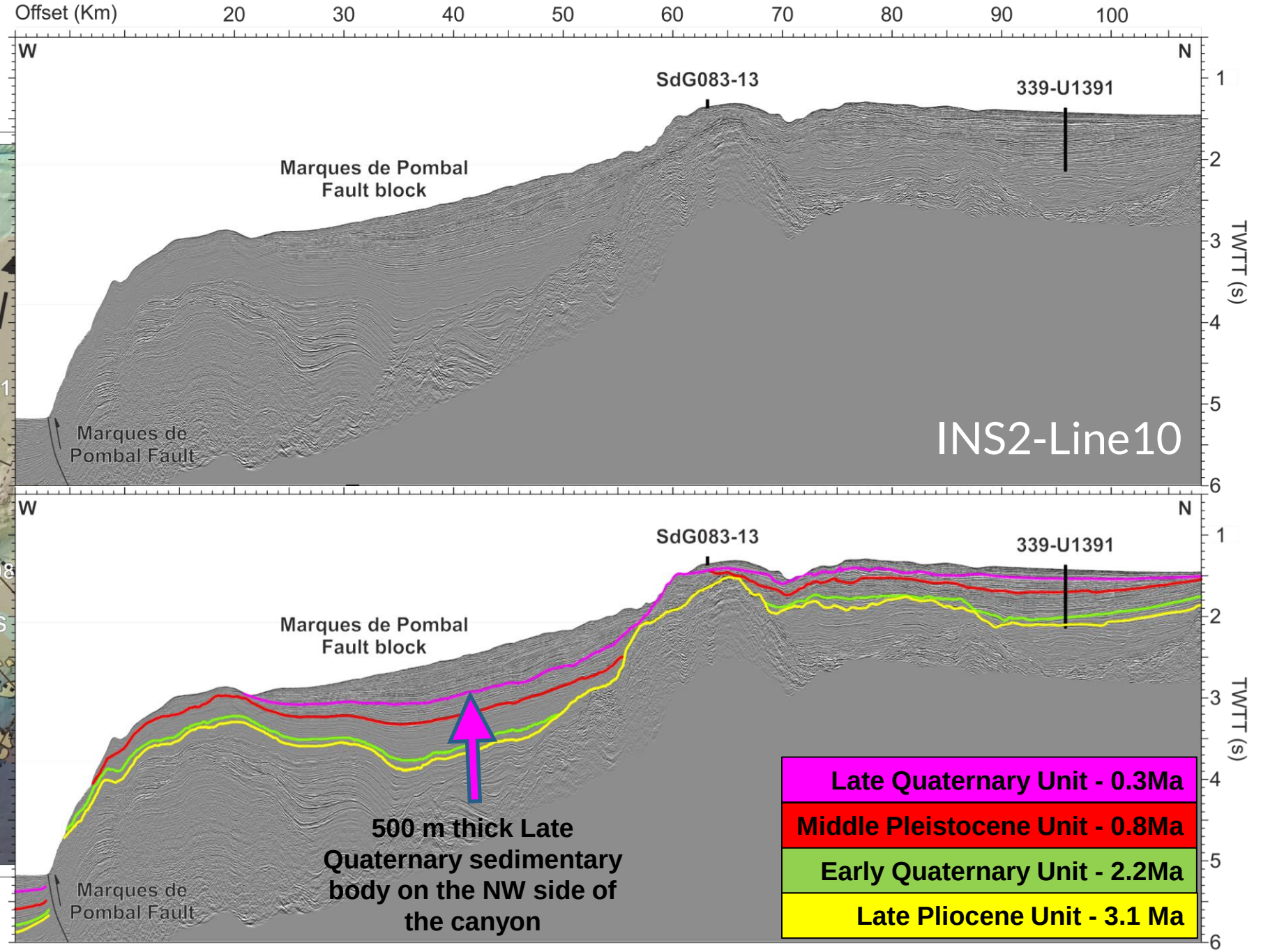
Main questions:

- How does the São Vicente Canyon interact with the MOW?
- Retrogressive erosion within the São Vicente Canyon generates turbidity currents within the contour current. Do they interact with contour current? Can we see depositional features related with mixed turbidity-contour currents (e.g. asymmetric levee)?
- Can the interaction between São Vicente Canyon and MOW impact the slope stability in the area?



Interpretation





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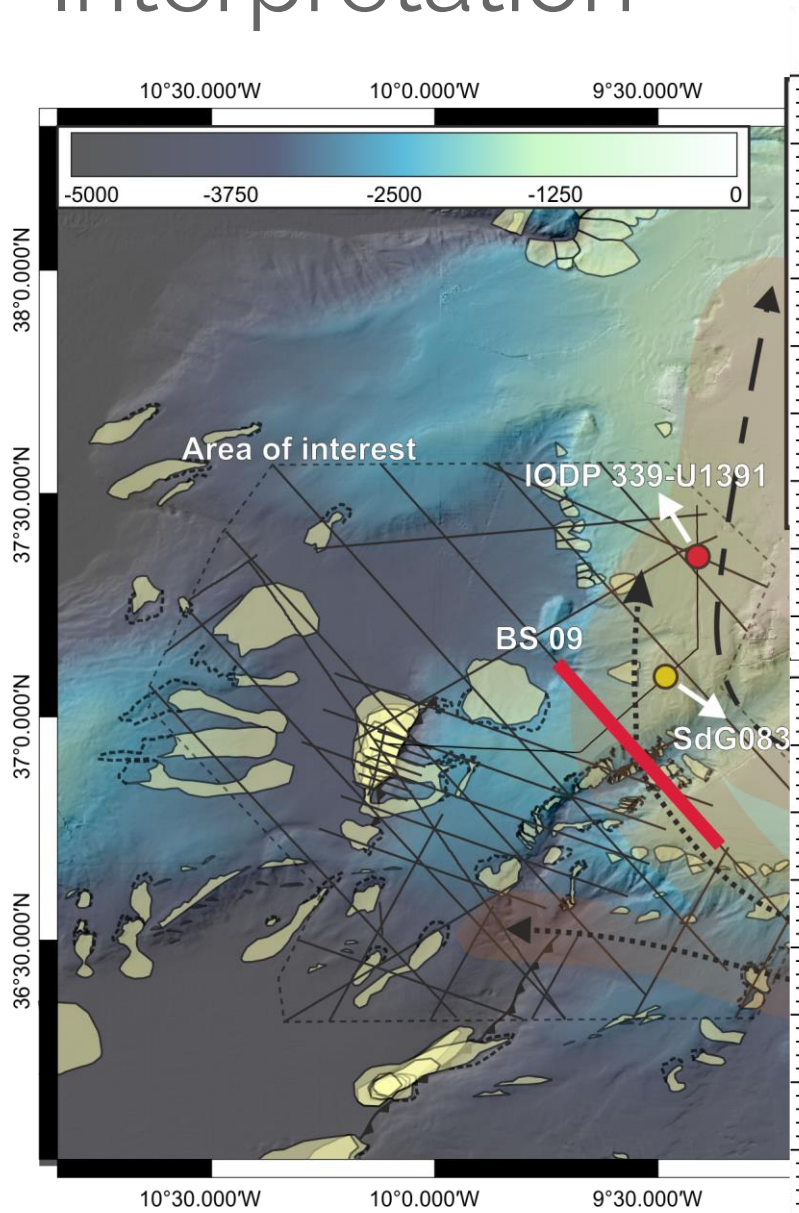
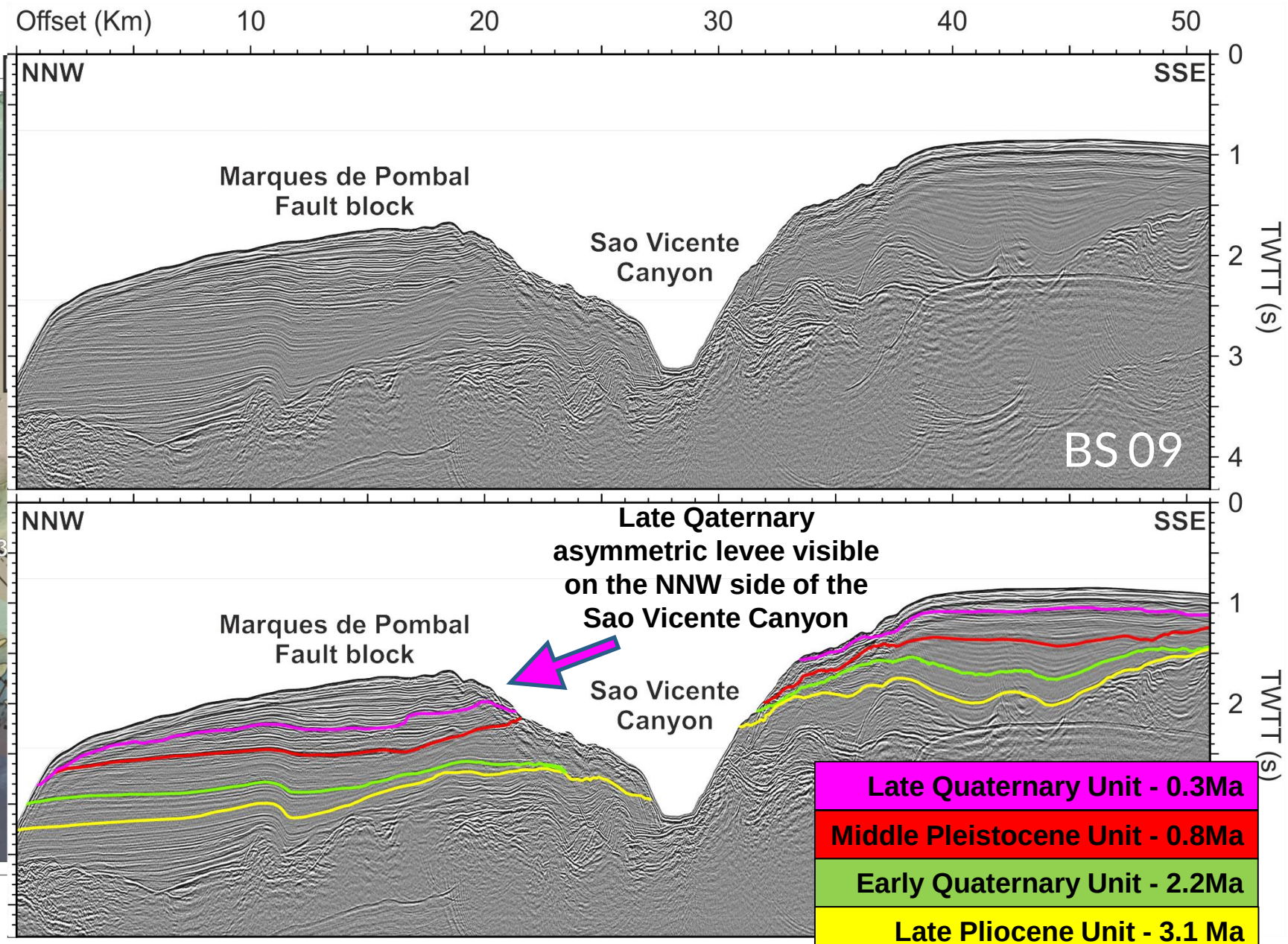
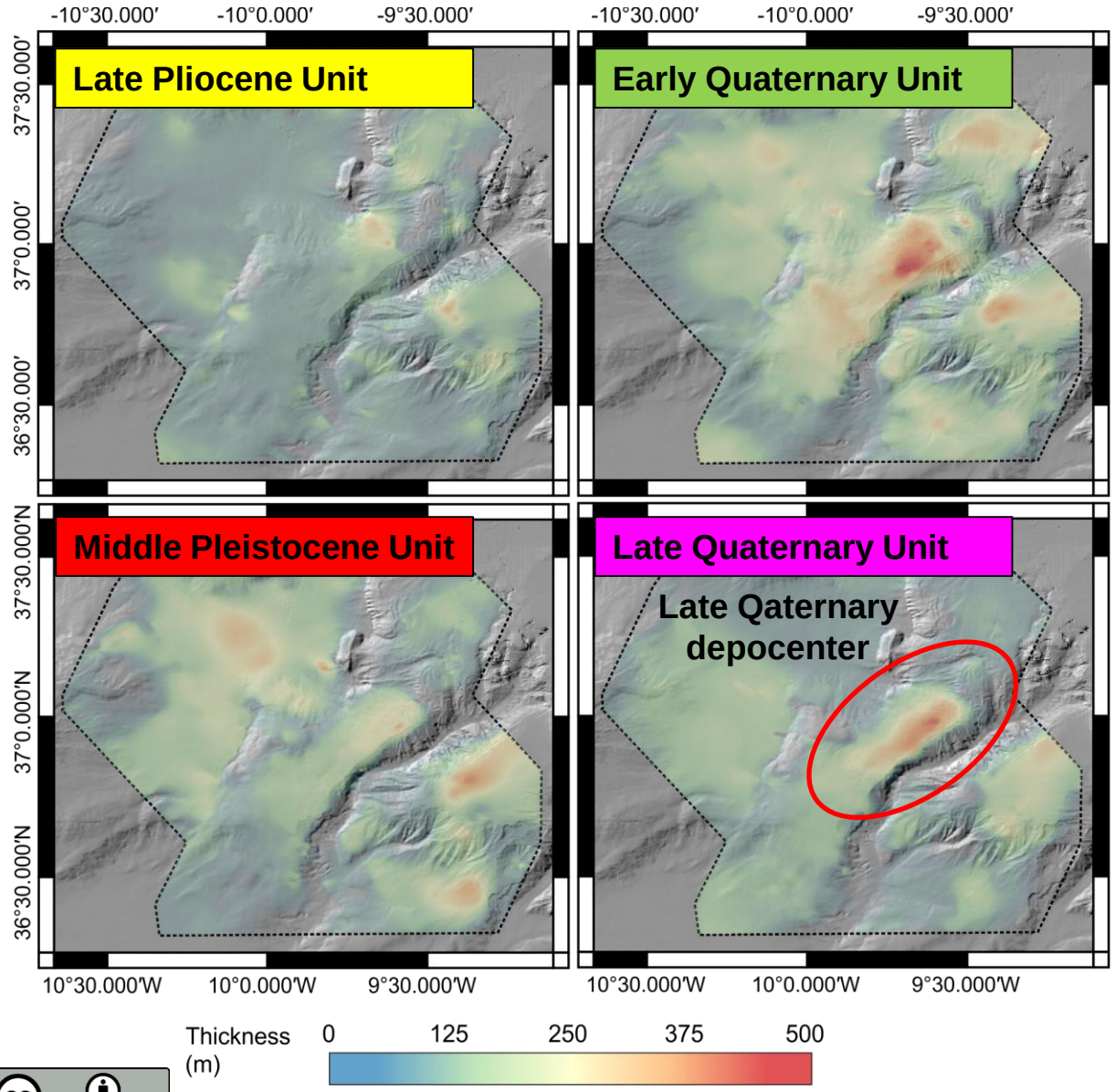
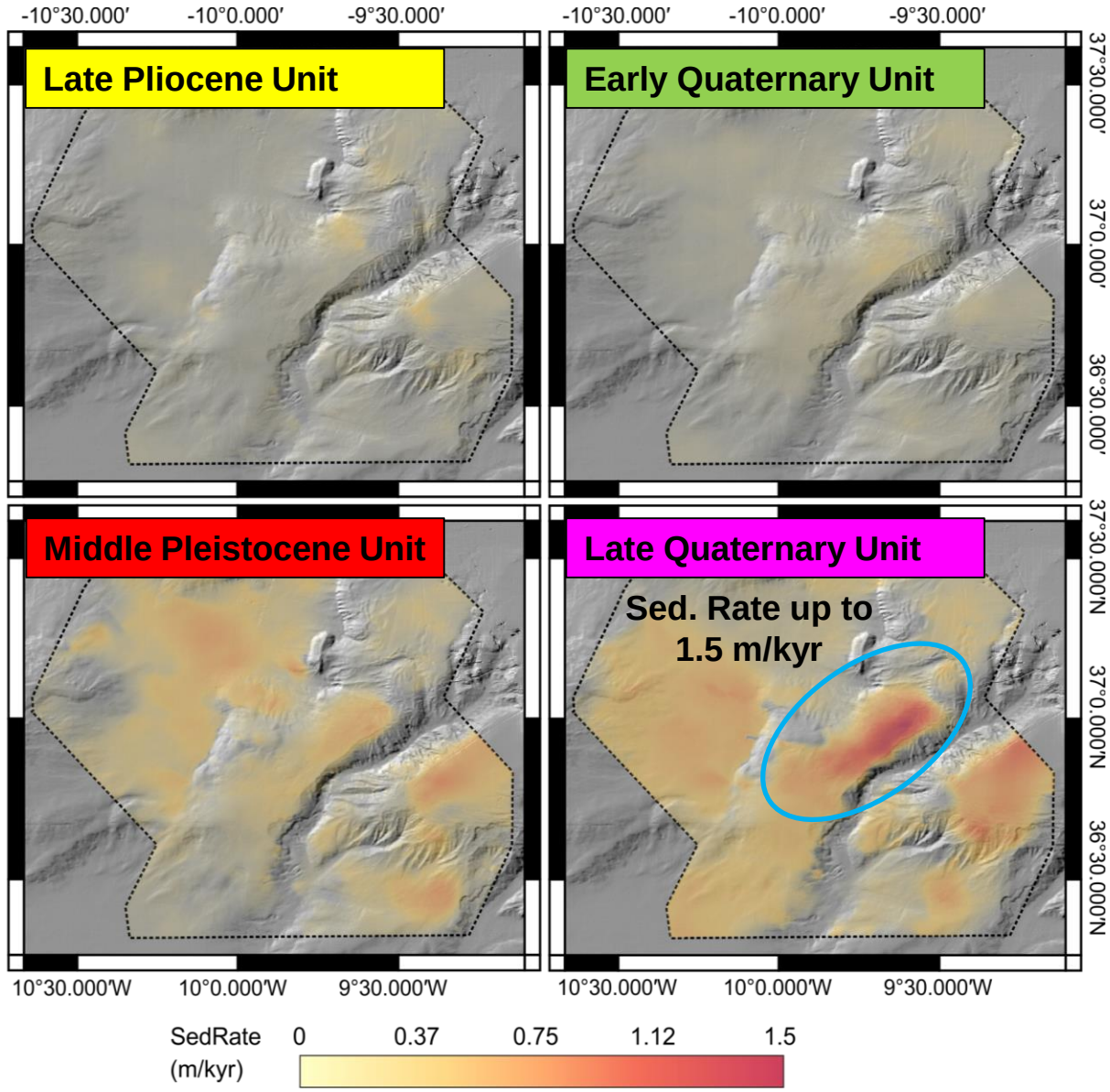




Thicknesses



Sedimentation rate



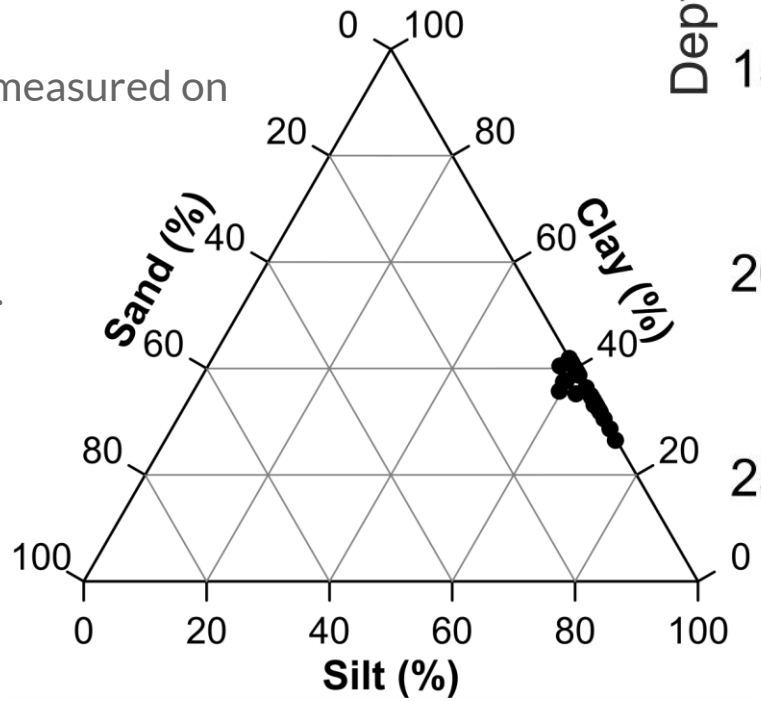
Gravity Core – SdG 083-13

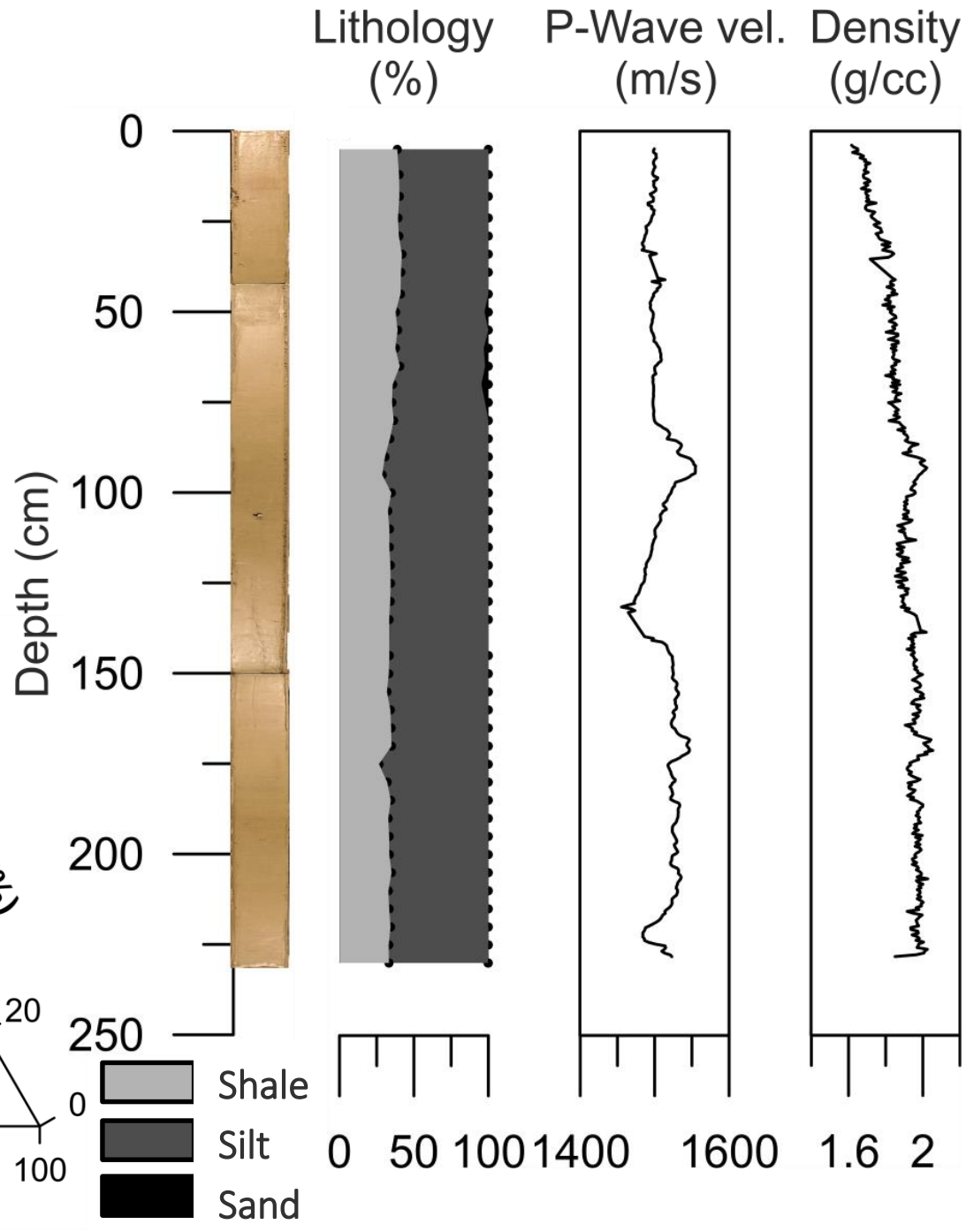
Grain size:

- Sampled using 5 cm spacing;
- Homogeneous silt-dominated grain size with high % clay.

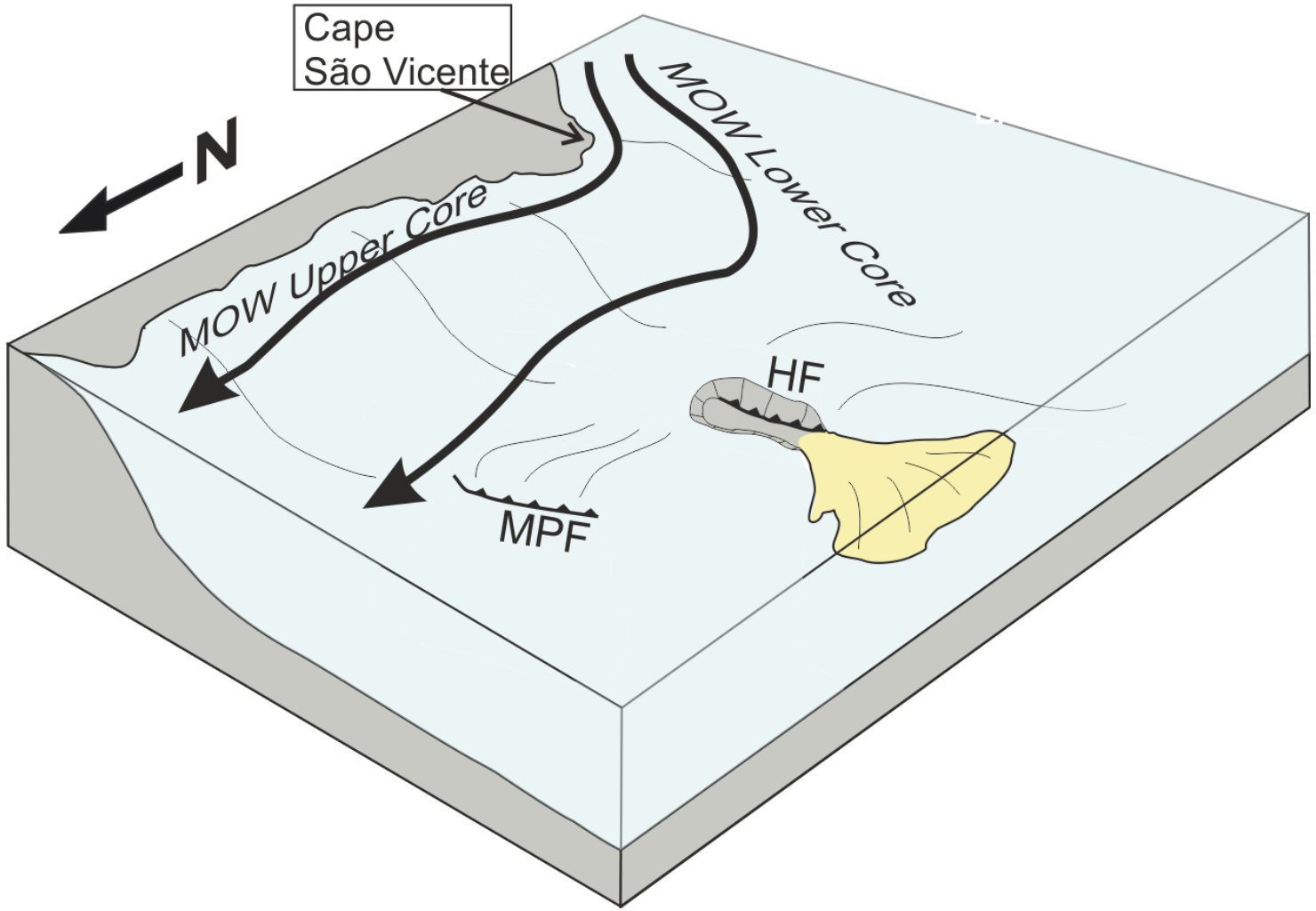
MSCL analysis:

- P-Wave velocity and density measured on the whole core;
- No clear discontinuities – Homogeneous top sediments.





Conceptual model

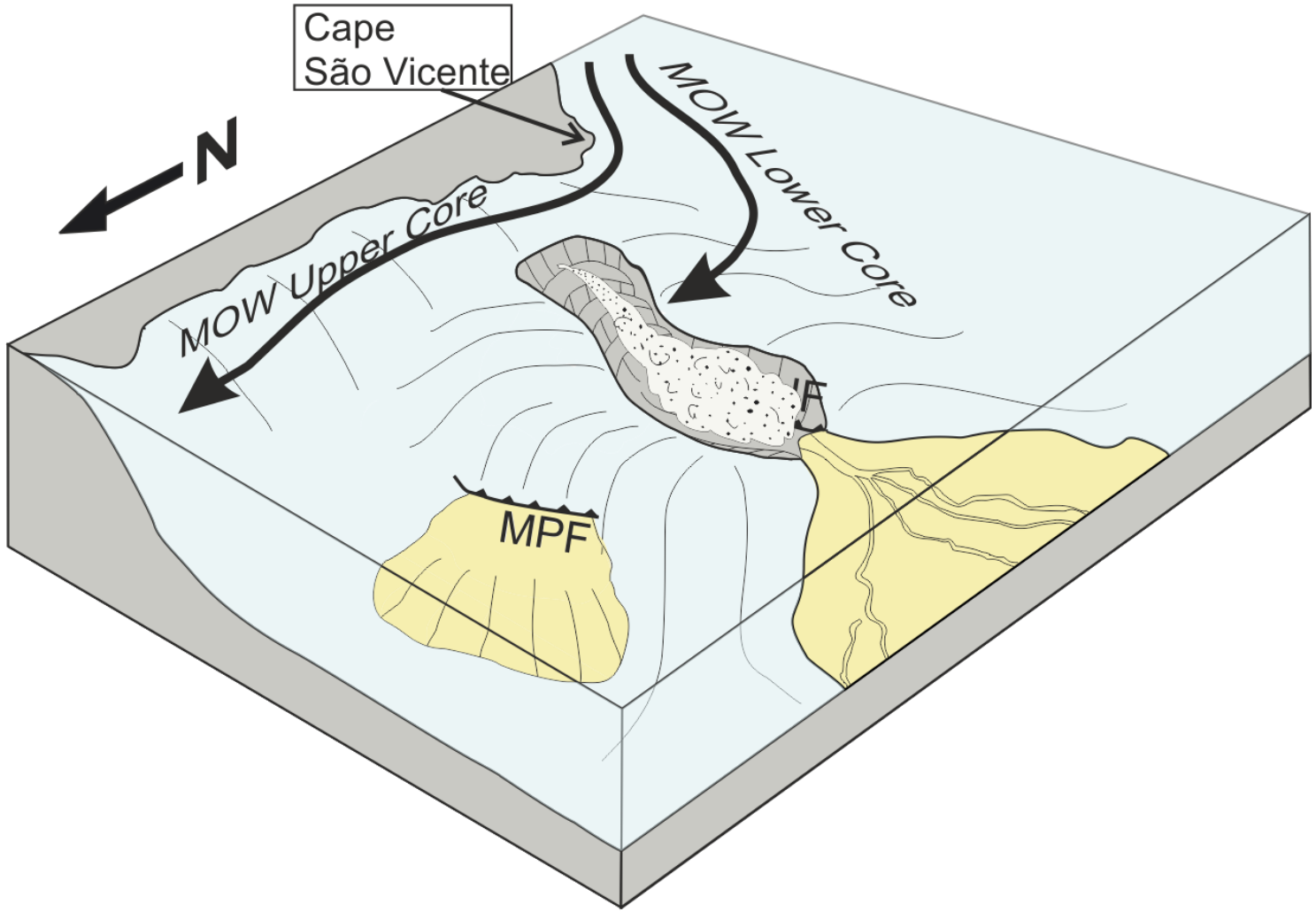


Modified after S. Serra et al., in press [1]

Pliocene

- The joined development of the Horseshoe Fault (HF) and Marques de Pombal Fault (MPF) generated a syncline fold where the deeper São Vicente Canyon sector emplaced;
- As the MOW flows at shallower depth (1500), the contour current did not interact with the canyon at this stage.

Conceptual model

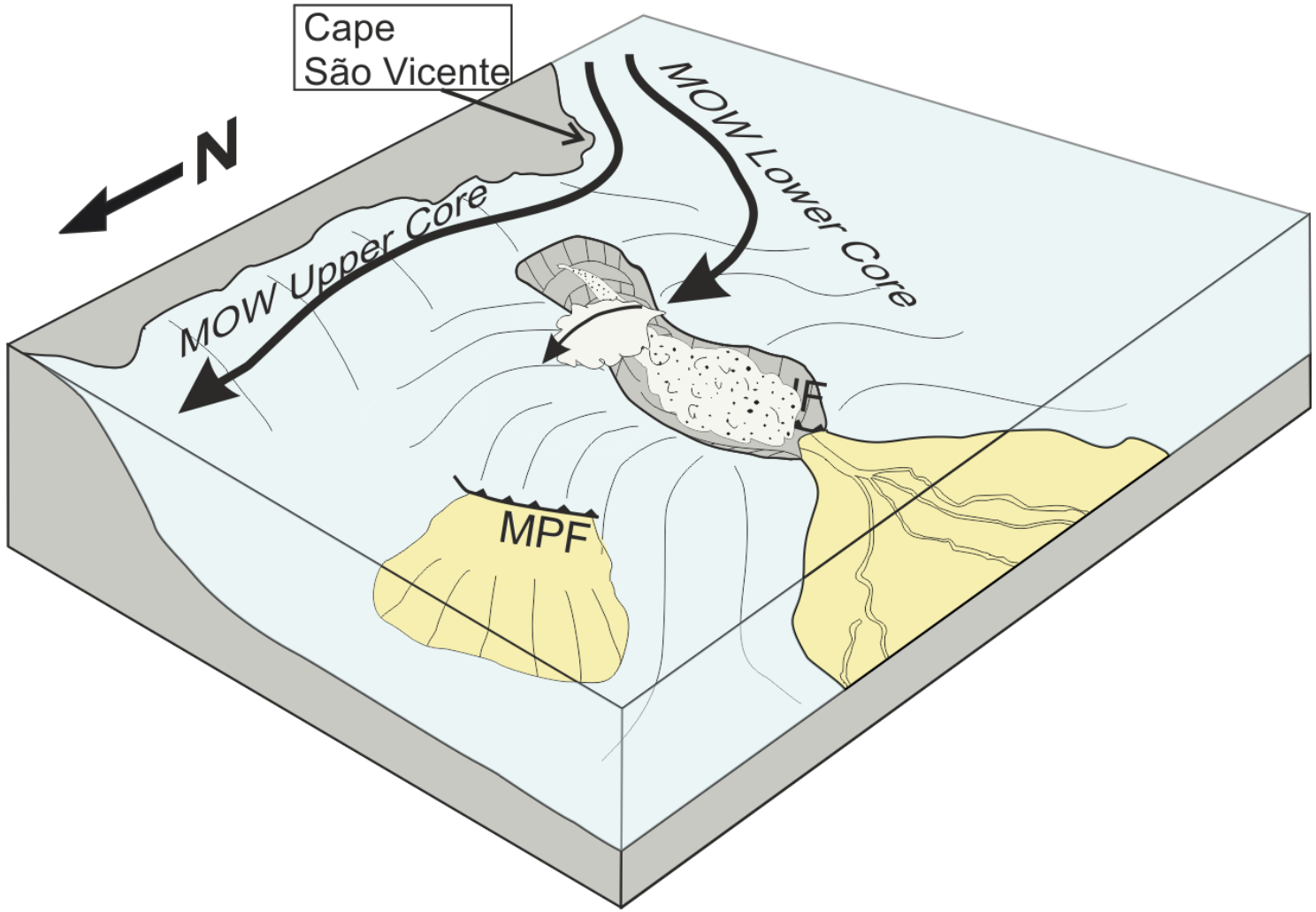


Modified after S. Serra et al., in press [1]

Late Quaternary

- Retrogressive erosion let the canyon expand until its current configuration (head located at approximately 200 m water depth);
- Generation of turbidity currents that transport the eroded sediments from the shallower part of the slope to the Horseshoe abyssal plan;

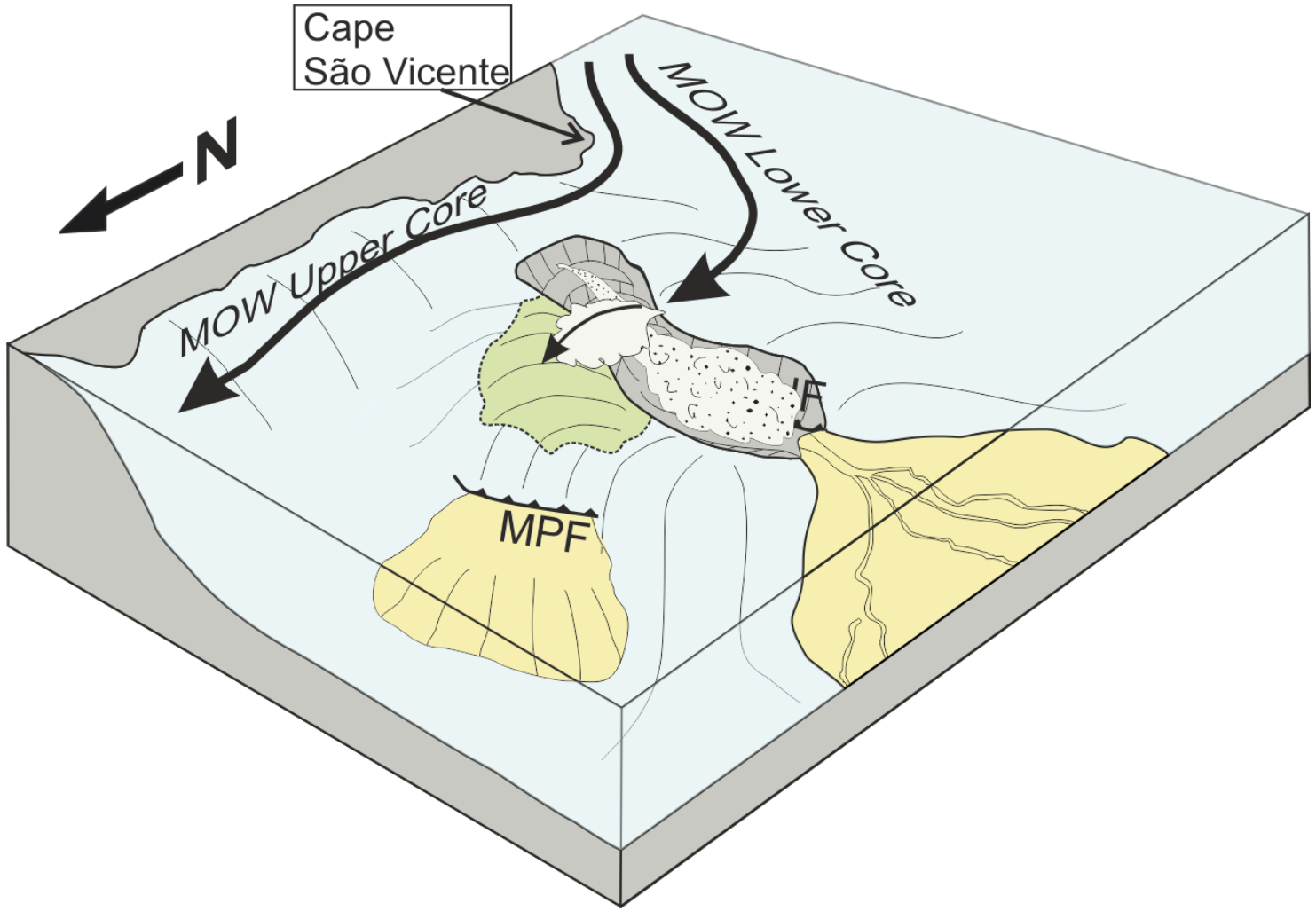
Conceptual model



Late Quaternary

- MOW Lower Core flows perpendicular to the canyon: a fraction of the water is captured by the canyon, while the remaining part is able to bypass the canyon with a considerable power loss;
- MOW interacts with the finer part of the turbidity cloud, transporting it on the NW side.

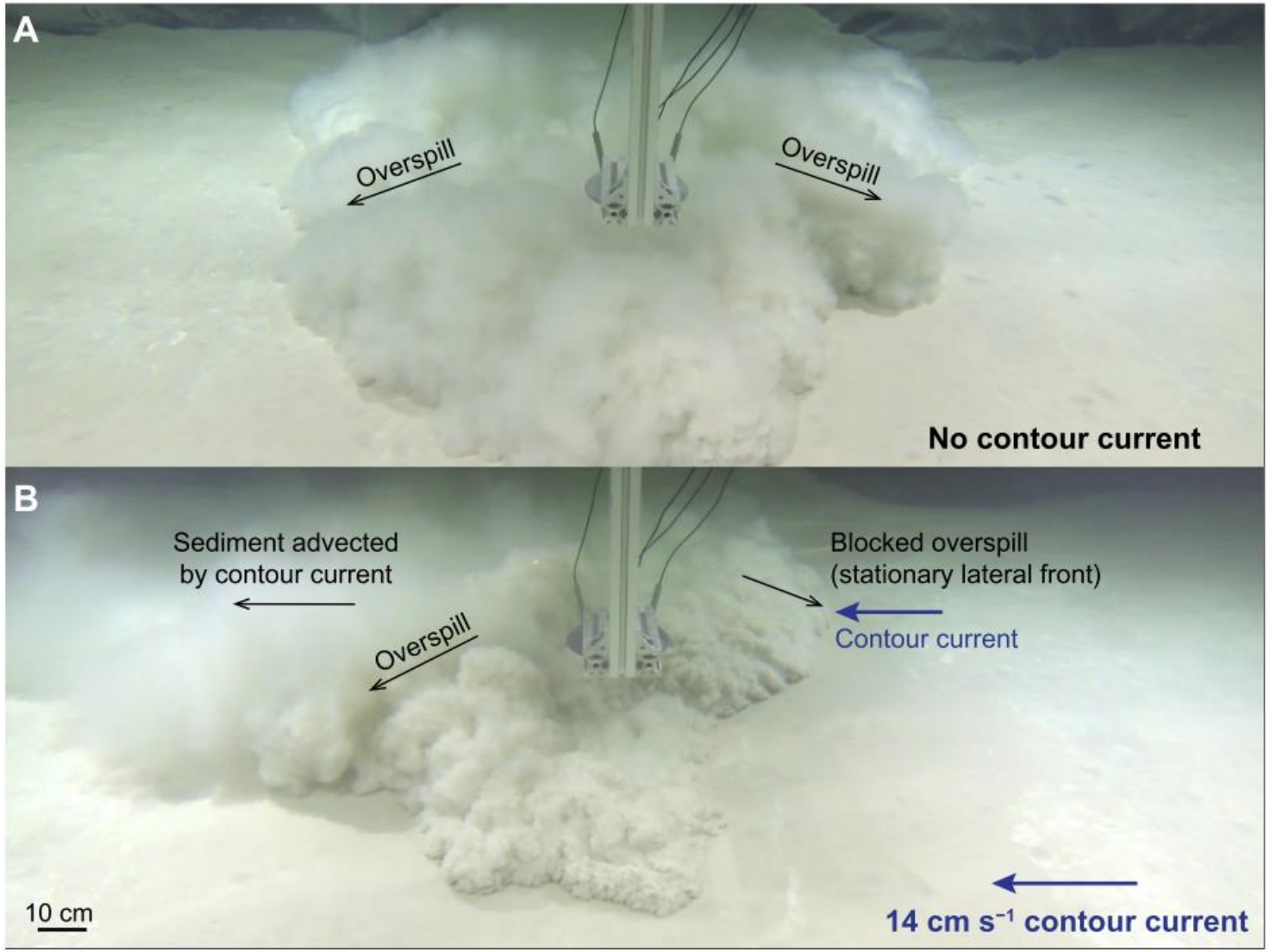
Conceptual model



Late Quaternary

- The finer fraction of the turbidity currents are deposited on the MW side of the Sao Vicente Canyon, forming an hybrid levee-drift sedimentary body as it is visible from the seismic interpretation.

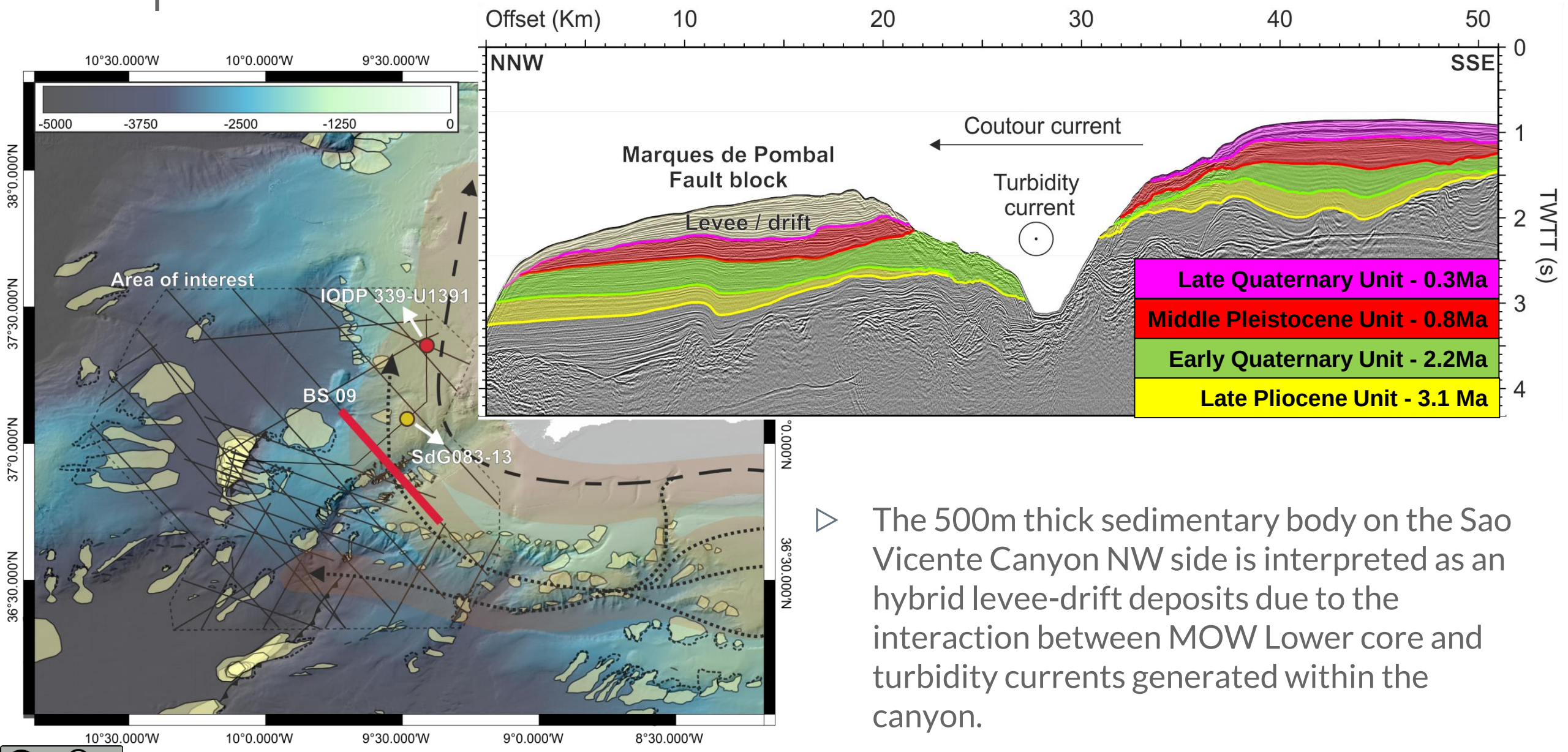
Previous studies



From Miramontes et al., 2020 [6]

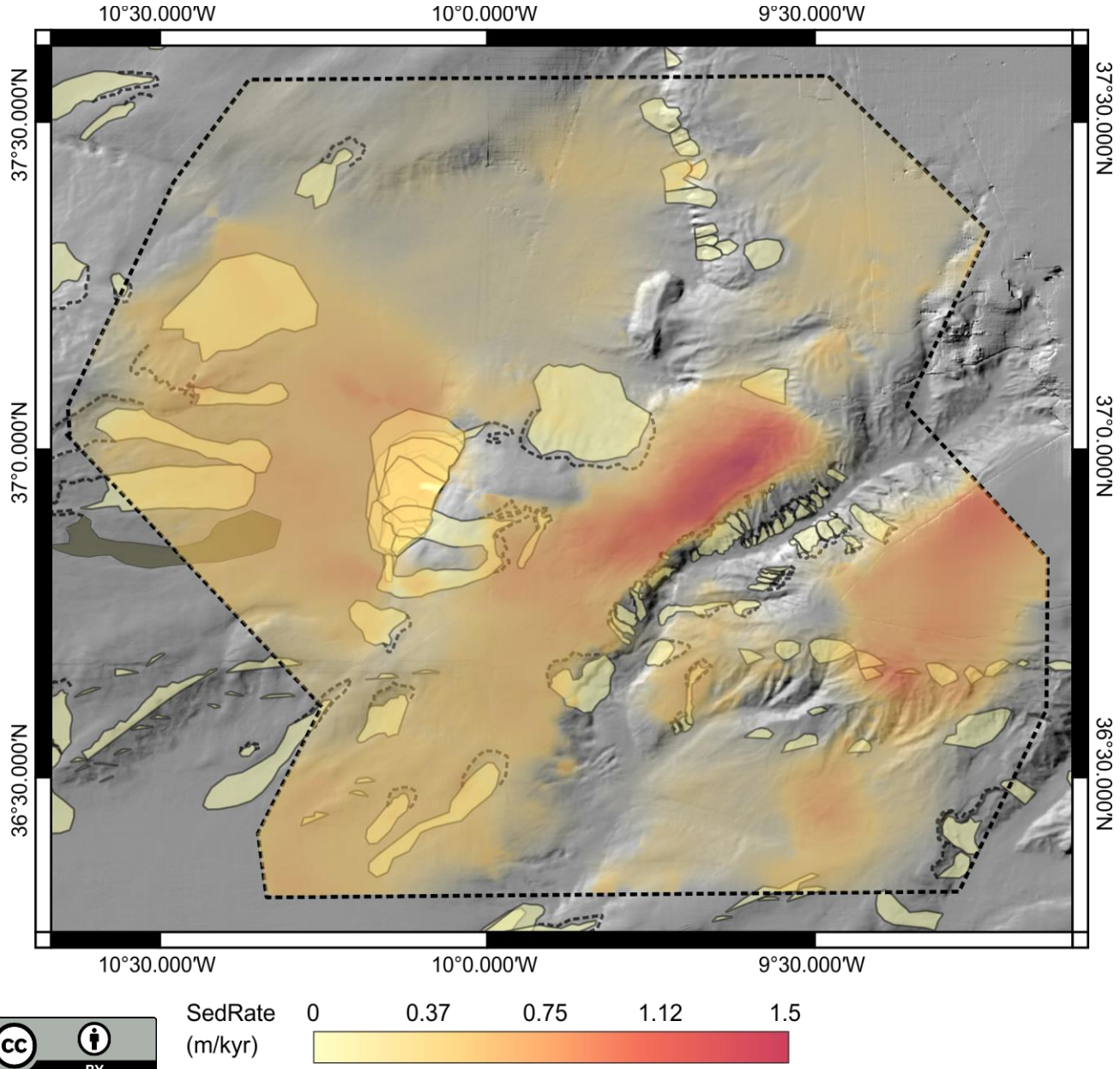
- Multiple previous study recorded the existence of mixed turbidity-contour systems in smaller scale turbidity channels [3, 4, 5];
- Experimental models from Miramontes et al. (2020) [6] simulated the interaction between turbidity and contour currents. The experiments resulted in generation of hybrid levee-drift deposits on the side of turbidity channels.

Interpretation



- The 500m thick sedimentary body on the Sao Vicente Canyon NW side is interpreted as an hybrid levee-drift deposits due to the interaction between MOW Lower core and turbidity currents generated within the canyon.

Implications for submarine slope stability



- Many mass transport deposits in the Alentejo basin distribute around the Late Quaternary area of high sedimentation rate on the Marques de Pombal Fault block;

- The localized high sedimentation rate (up to 1.5 m/kyr), plus the assumed fine sediments of the sedimentary body, are likely to generate high overpressure in the underlying units;

THE QUICK SEDIMENTATION OF THE THICK HYBRID LEVEE-DRIFT AFFECTED THE STABILITY OF THE SLOPE

Conclusions

- The interaction between the MOW and turbidity currents within the São Vicente Canyon generated a Late Quaternary hybrid levee-drift deposits on top of the Marques de Pombal Fault block;

- Asymmetric channel-levee system can generate not only on turbidity channels, but also bigger size canyons;

- Mass transport deposits in the Alentejo basin distribute mainly around this high sedimentation rate area, suggesting that the hybrid levee – drift deposits might play an important role as pre-conditioning factor for submarine slope stability (e.g. excess pore pressure generation).

References

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