

# **Contourite Sheet Sands: New Deepwater Exploration Target\***

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## **Abstract**

Arguably the largest known, present-day, deepwater sandy deposit is a contourite sand sheet located in the eastern Gulf of Cadiz on the Iberian continental slope. It extends from the Gibraltar oceanic gateway towards the northwest for at least 100 km along a mid-slope terrace at a mean water depth of 500-700 m. It covers an estimated area of around 4000 km<sup>2</sup>, with a known thickness for a single unit being in excess of 10 m in a proximal location. High-resolution seismic data indicate that this unit is more probably 40 m thick. Deeper penetration (multichannel) seismic data further suggest there may be at least 800 m of sand-rich contourite section in the immediate subsurface. This is inferred to have a high net to gross ratio (>50% sand). Towards its distal extremity the sand sheet passes into three discrete contourite channels, the largest of which (the Cadiz Channel) funnels sand alongslope and downslope to water depths exceeding 1200 m. This channel is floored by a series of large active sand waves and, locally, by gravel lag deposits.

Preliminary sediment analyses of selected cores reveal clean, well-sorted sands that would potentially yield excellent reservoir characteristics on burial. This sand sheet is fed mainly from shelf sands that are fed downslope through proximal turbidity current channels and by shelf spillover processes onto the middle slope. The sands are then redistributed alongslope by powerful bottom currents formed from Mediterranean Overflow Water. They form part of a much larger well-established contourite depositional system in the Gulf of Cadiz, which becomes dominantly mud-rich in medial to distal parts as the bottom current velocity and hence transport capacity decreases away from the Gibraltar gateway. Certainly these same processes and deposits will have been equally active in the geological past, along other margins as well as the Iberian margin. We propose, therefore, that such contourite sands should form a serious and specific deepwater exploration target in the subsurface. However, more work is required on modern analogues such as the Cadiz Sand Sheet in order to better characterise and understand these novel reservoir targets.

# Contourite Sheet Sands: New Deepwater Exploration Target



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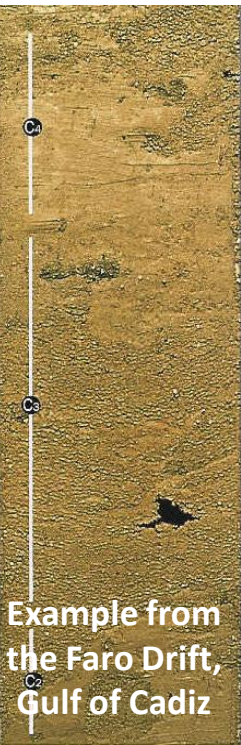
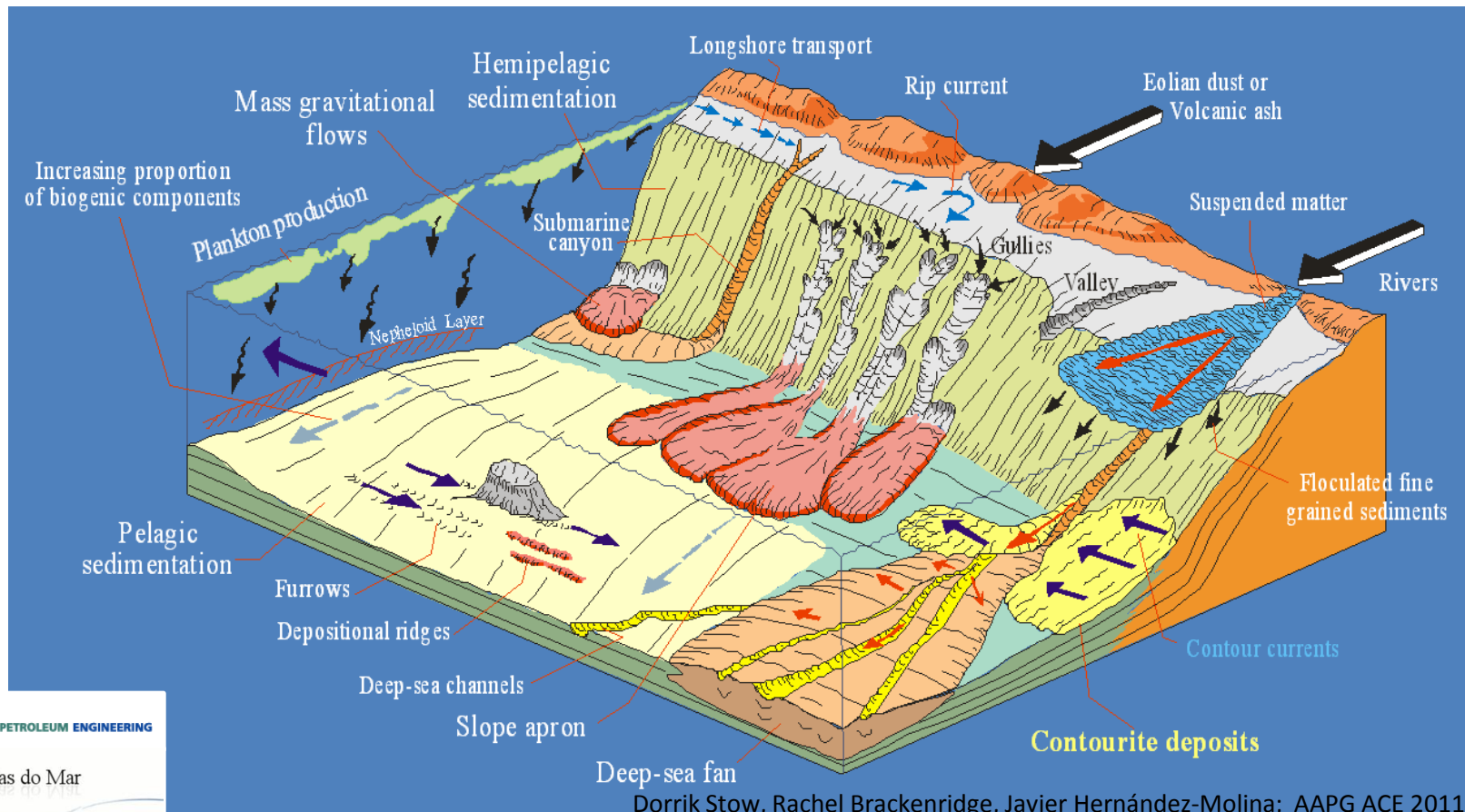
# Outline

- Introduction to Contourites
  - What is a contourite?
  - Distribution
- Sandy Contourites
  - Case study: Gulf of Cadiz
  - Distribution
  - Characteristics
- Petroleum Potential
  - Reservoir potential
  - Seal/source/trap
  - Examples
  - Sequence stratigraphy?
- Conclusions

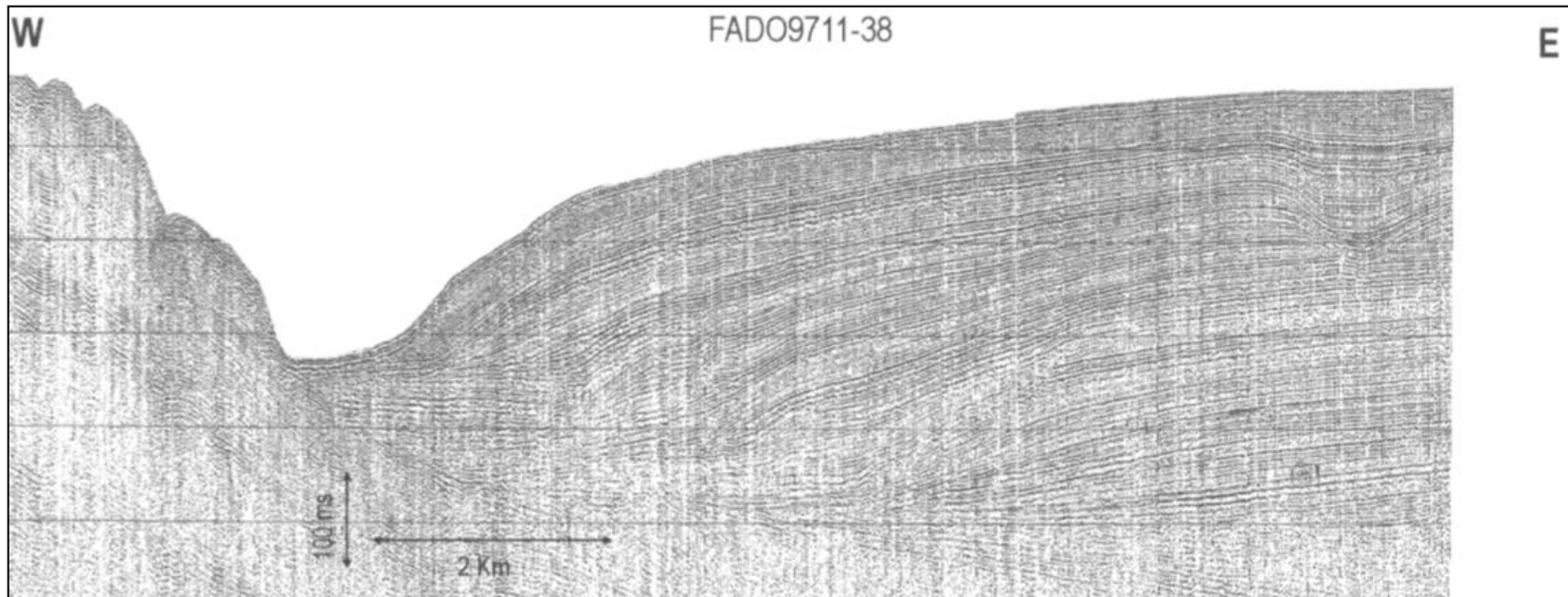


# Introduction to Contourites

*“Contourites are all those sediments deposited by or significantly affected by bottom currents acting in deep-water”*



# Introduction to Contourites



## Erosional features

- Erosive terraces
- Abraded surfaces
- Contourite Channels
- Contourite moats

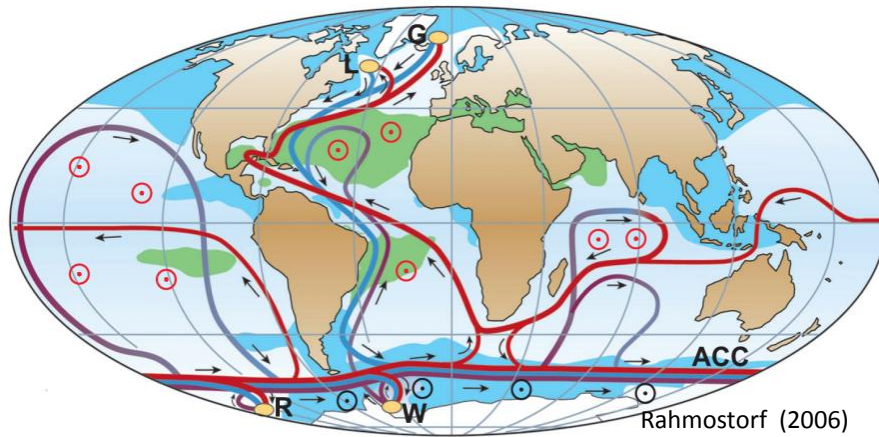
## Depositional features

- Sheeted drifts
- Mounded elongate drifts (separated & detached)
- Channel-related (parch and fan drifts)
- Confined drifts
- Infill drifts
- Mixed drift systems



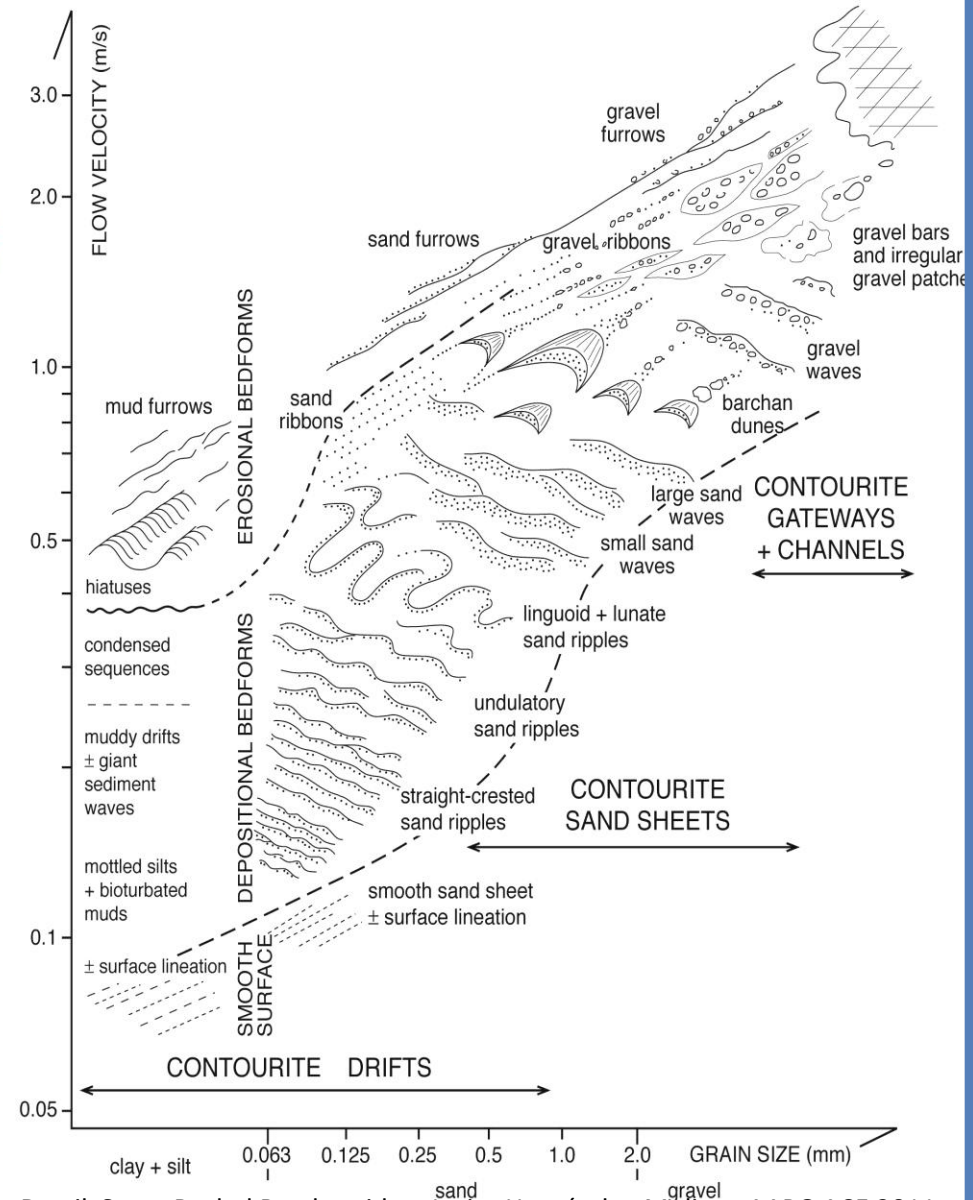


# Introduction to Contourites



Deposited where;

- BW currents reach sufficient velocities
- Where BW currents occur over a prolonged period of time
- Where there is a sediment supply



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# Sandy Contourites

## The Gulf of Cadiz Contourite Sand Sheet

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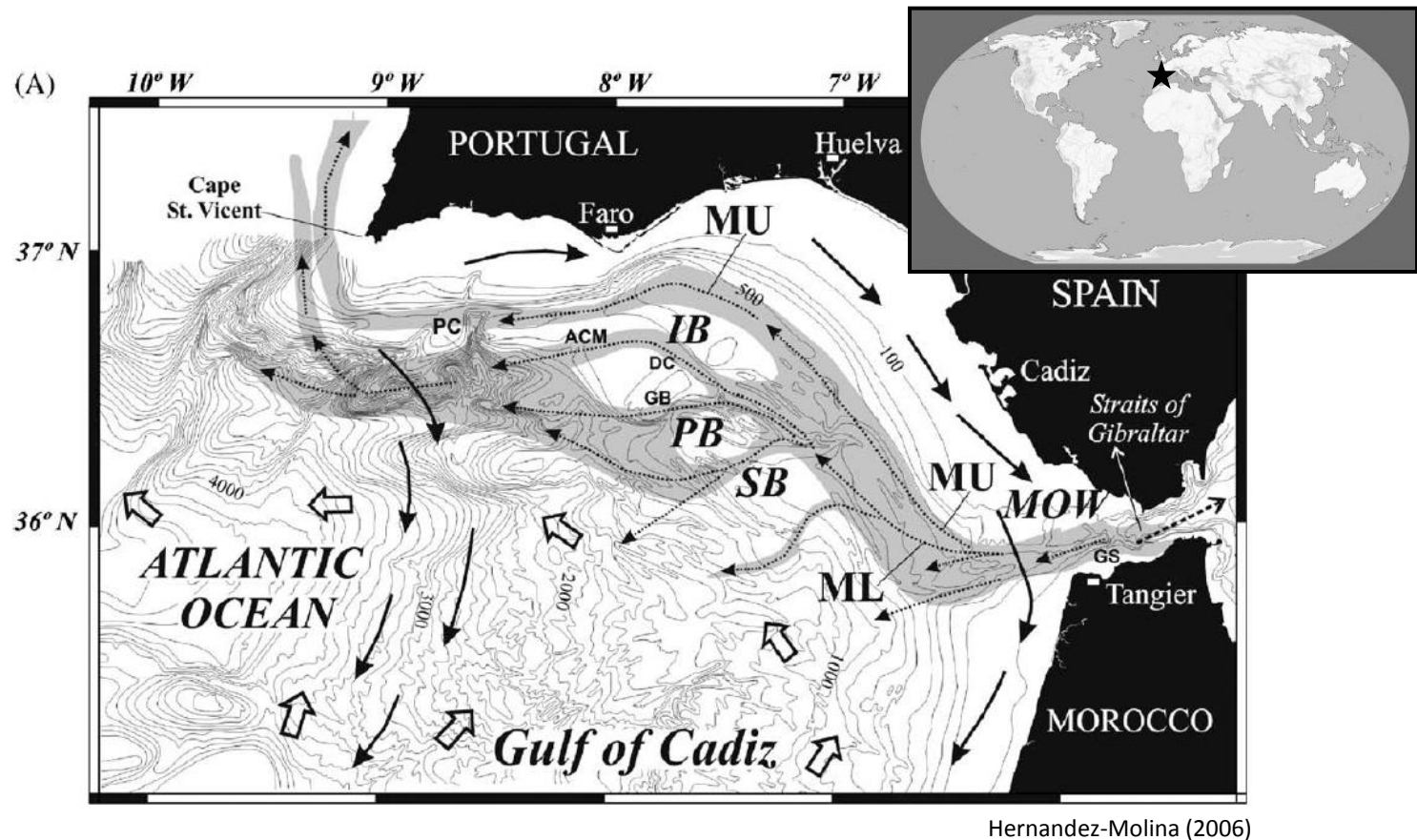
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# Sandy Contourites

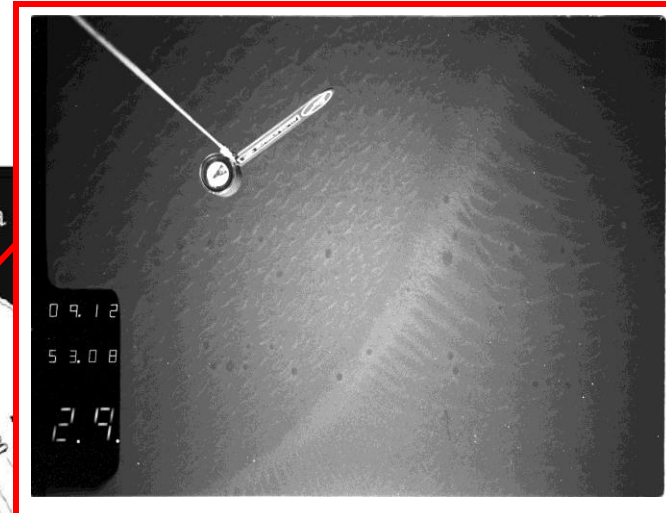
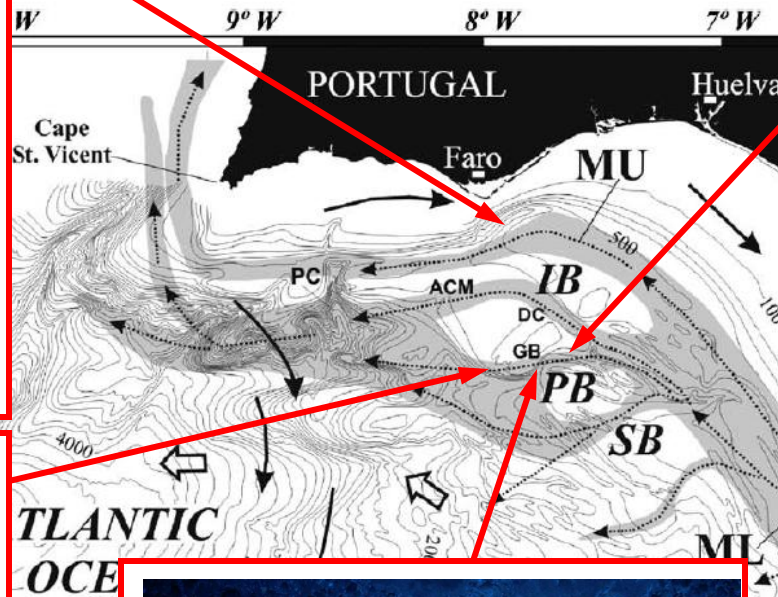
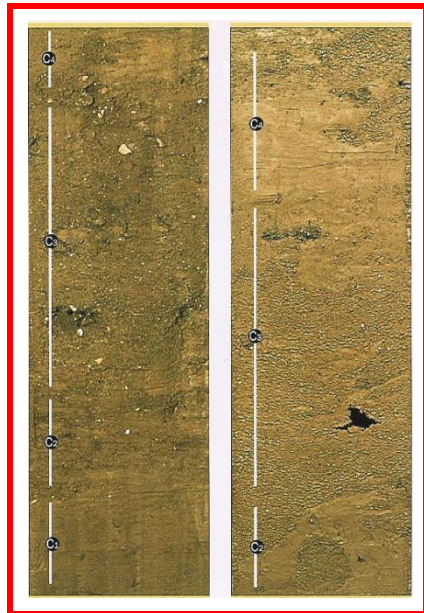
## Case Study



## GULF OF CADIZ

# Sandy Contourites

## Data

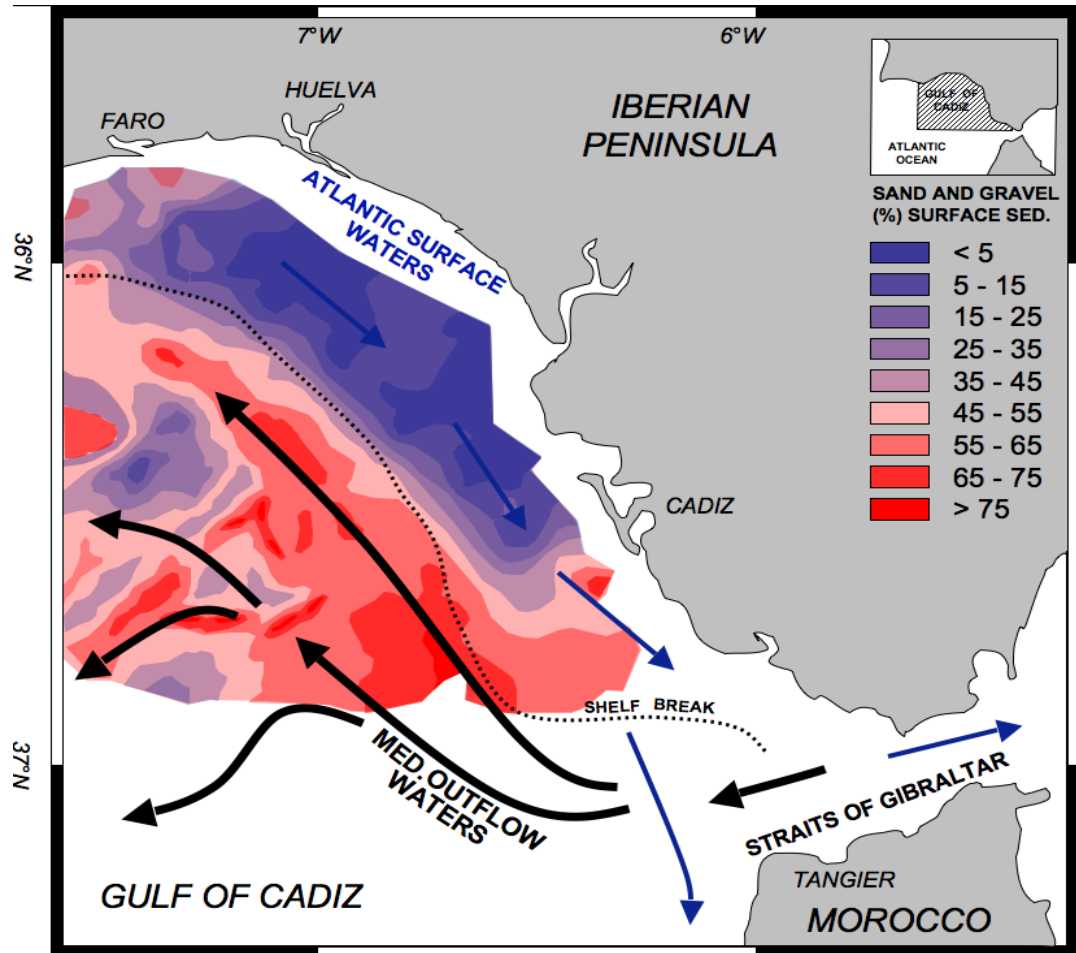




# Sandy Contourites

## Gulf of Cadiz Sand Sheet

- Sand distribution in the Gulf of Cadiz

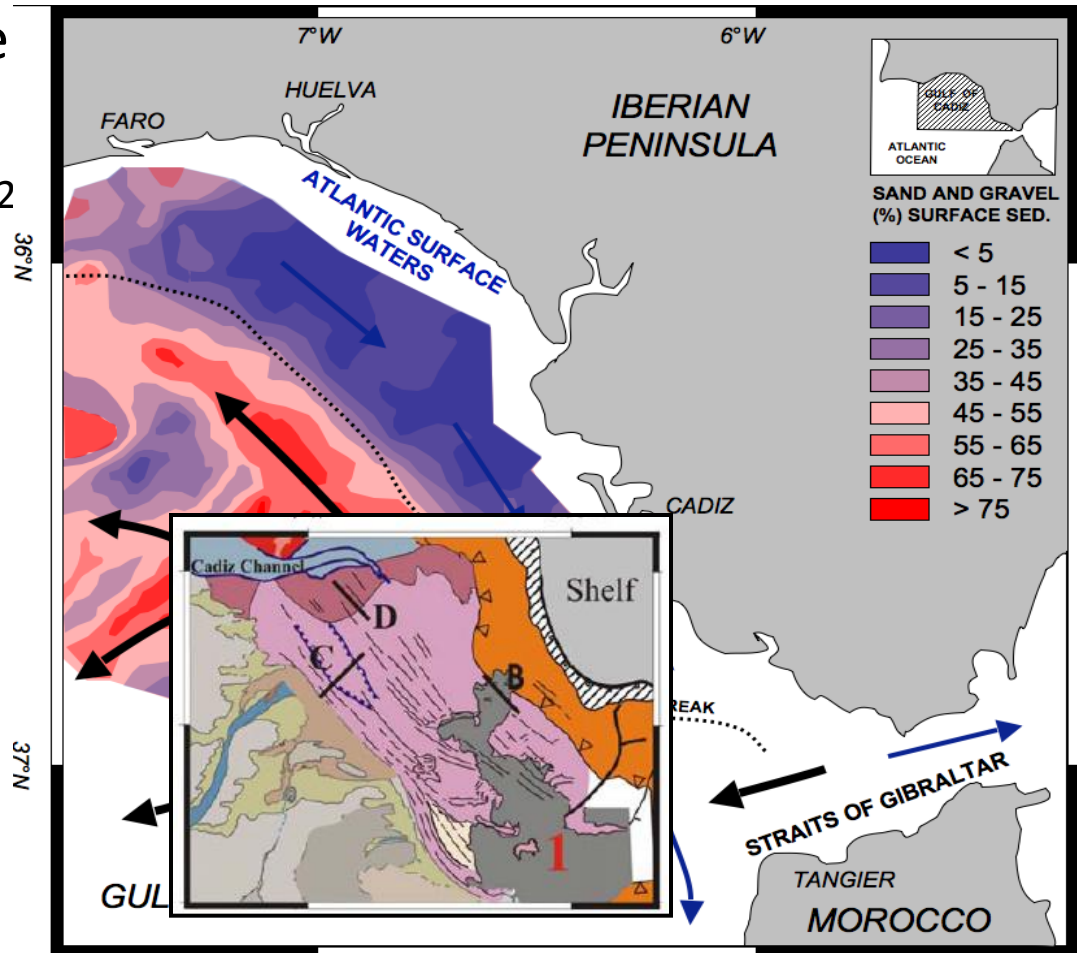


# Sandy Contourites

## Gulf of Cadiz Sand Sheet

*LARGEST KNOWN SINGLE SAND SHEET IN DEEPWATER AT PRESENT*

- Located proximally to the Straits of Gibraltar
- Estimated area; 4000 km<sup>2</sup>
- Extends along the mid-slope for at least 100 km
- Water depth 500-700 m
- Thickness: 800+m?
- High NTG



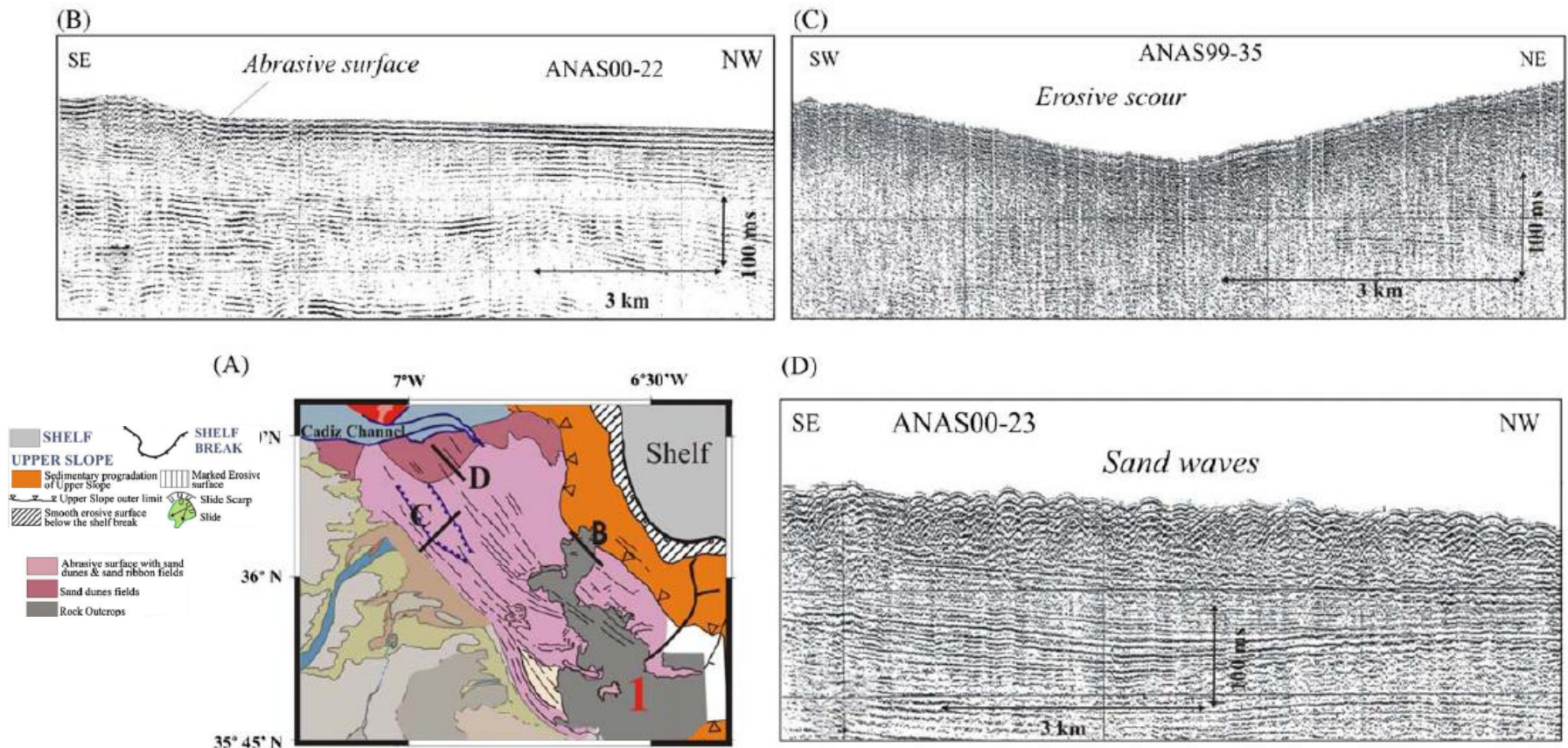


# Sandy Contourites

## Gulf of Cadiz Sand Sheet

Identification on seismic;

Erosive surfaces; linear features; orientated morphology;  
bedforms; high amplitude seismic facies

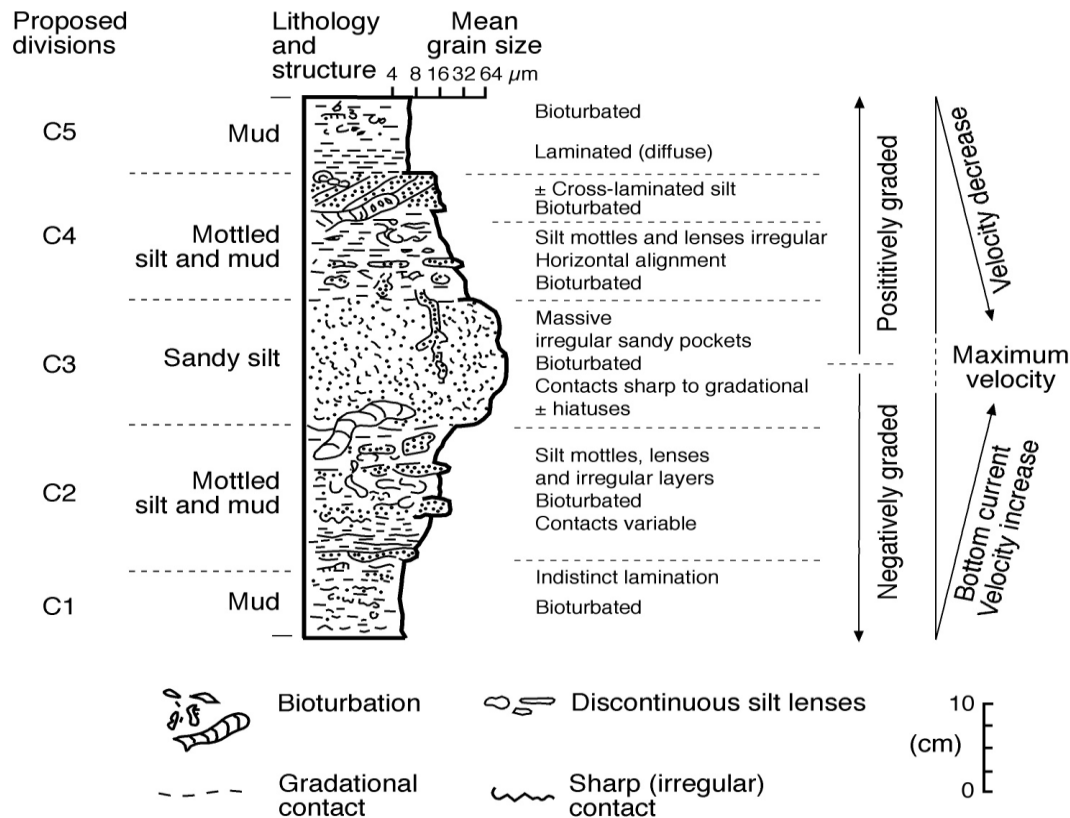


# Sandy Contourites

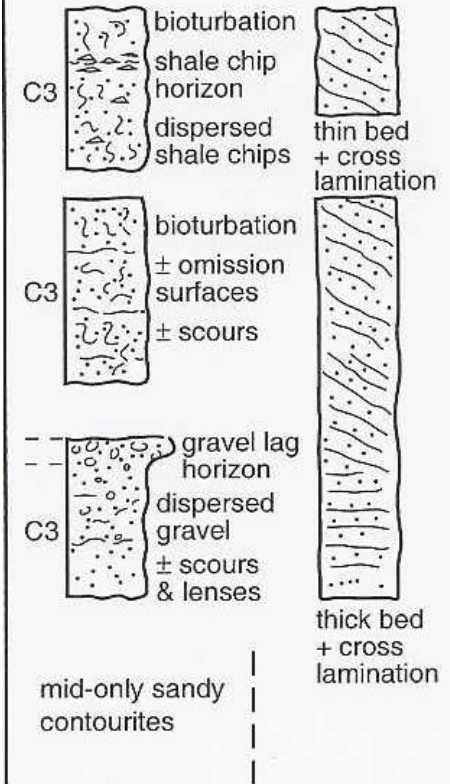
## Gulf of Cadiz Sand Sheet

### Identification in cores

### Gradational changes between facies



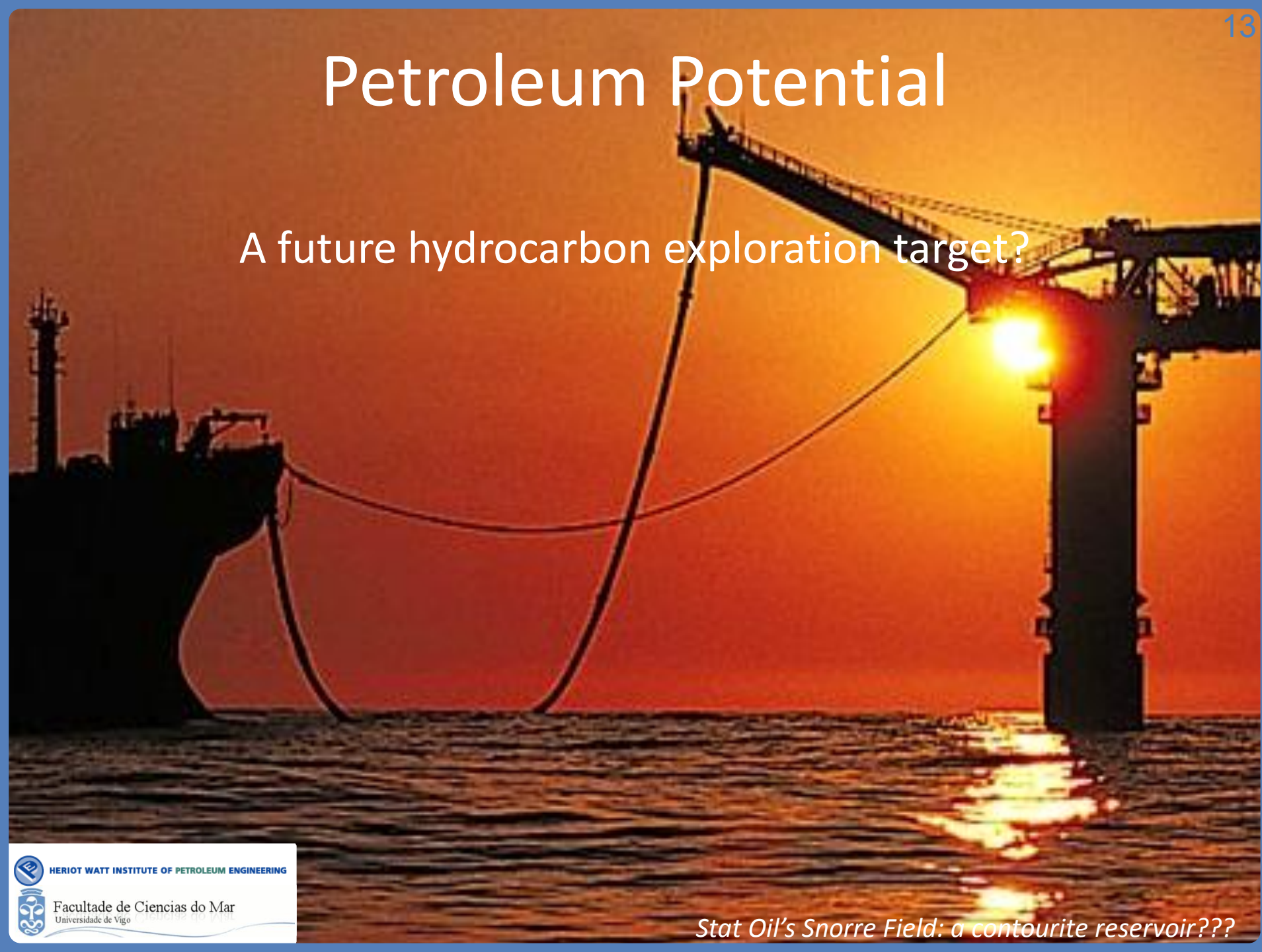
### sandy contourites





# Petroleum Potential

A future hydrocarbon exploration target?



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*Stat Oil's Snorre Field: a contourite reservoir???*

# Petroleum Potential

## RESERVOIR POTENTIAL

**CLEAN SANDY CONTOURITE FACIES**  
**A future petroleum reservoir target!**



High NTG , clean well-sorted sands demonstrated to exist  
where bottom water velocities and sediment supply allow



# Petroleum Potential

## SEAL POTENTIAL

**MUDDY CONTOURITE FACIES & NORMAL PELAGIC  
SEDIMENTATION**  
**Good seal potential**

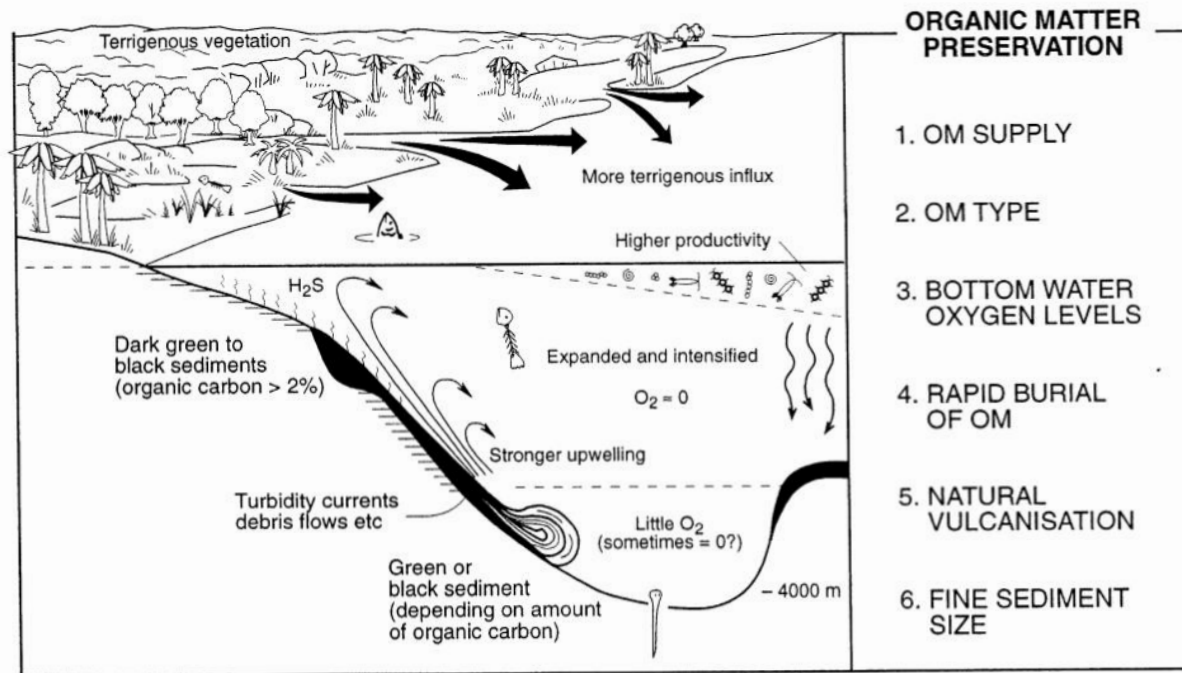


- Slowing velocities (due to changing oceanographic conditions) can lead to mud deposition
- Good stratigraphic trapping potential

# Petroleum Potential

## CHARGE

### SLUGGISH FLOW OR EXTERNAL SOURCE ROCK REQUIRED



- Deepwater sources known to be in existence and producing.
- No reason to presume contourites don't contain high TOC



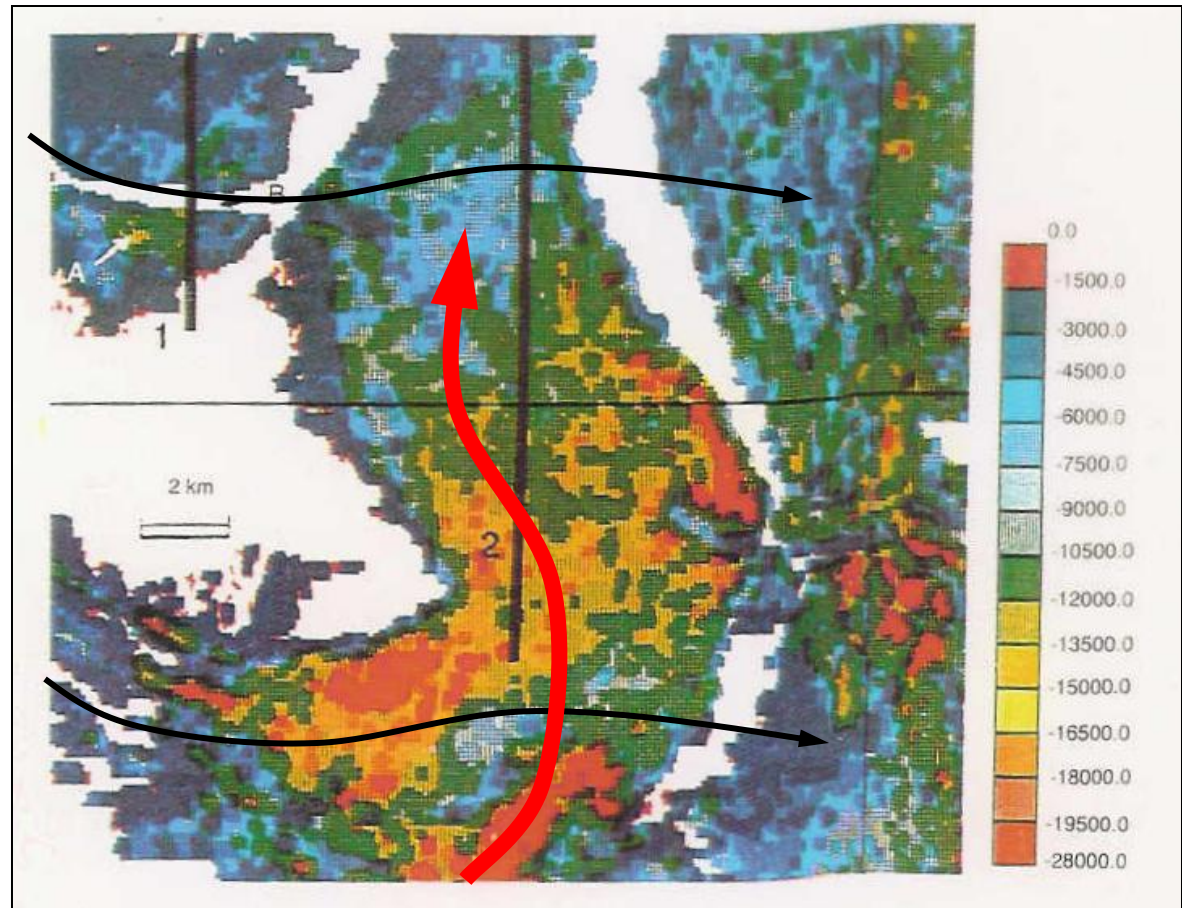
# Petroleum Potential

## BUT DOES IT WORK?

- Marlim Oilfield, Campos Basin

Upper reservoir = a re-worked turbidite CONTOURITE

Top Oligocene  
amplitude Map  
shows alongslope  
trends and  
downslope  
features.



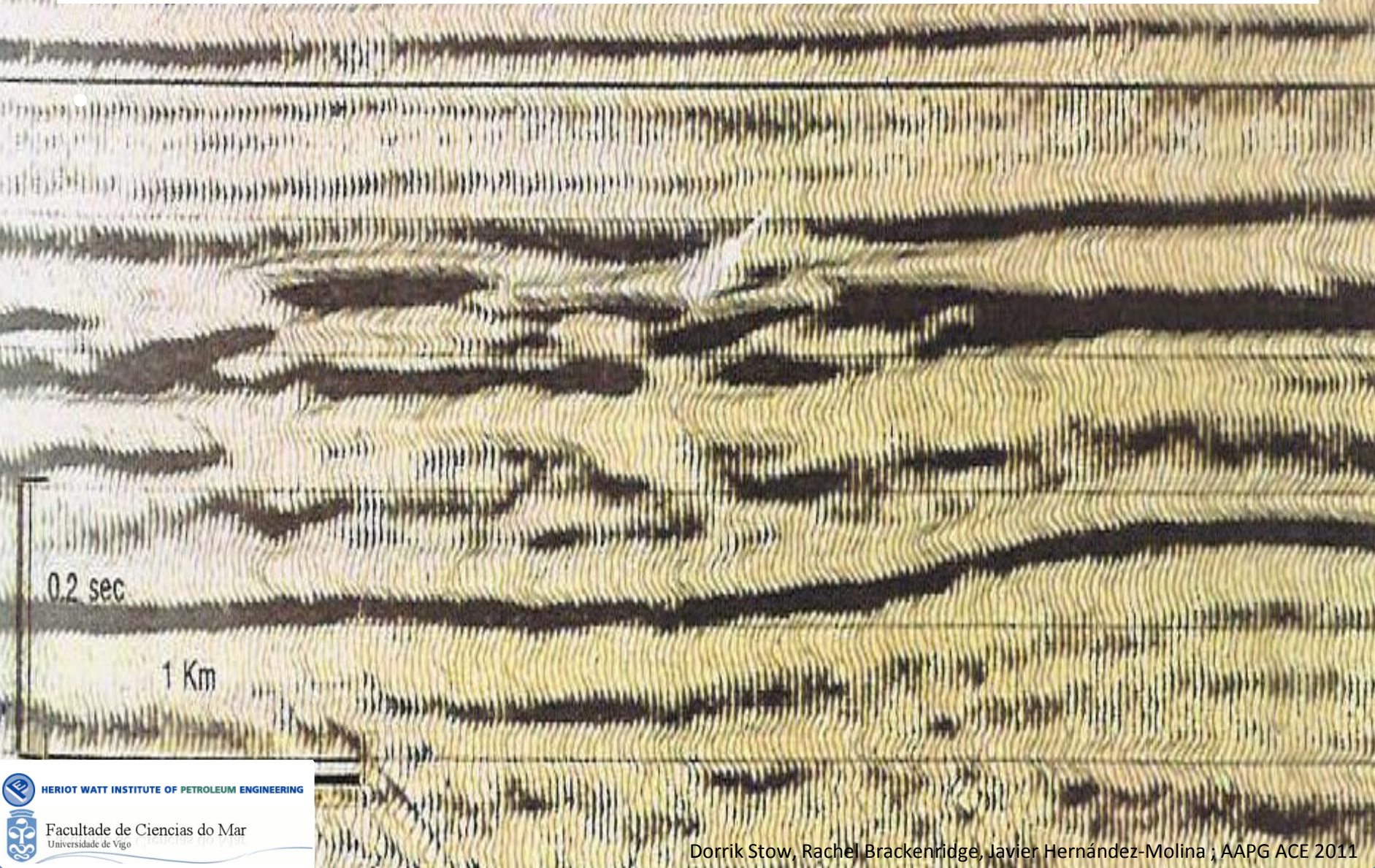
# Petroleum Potential

## BUT DOES IT WORK?

- Marlim Oilfield, Campos Basin  
Part re-worked turbidite CONTOURITE reservoir
- Snorre Oilfield, North Sea  
Isolated massive sand body: Contourite?
- Gulf of Cadiz?
- Gulf of Mexico?
- Unidentified contourite plays elsewhere??
  - Greenland?
  - Arctic?



# Conclusions





# Conclusions

- Contourite sand sheets are best prospect
- High-energy bottom current systems can produce clean contourite sands with good poroperm
- Extensive lateral sand development & connectivity
- Sufficient sand supply required
- Good potential for muddy contourite seal
- Good potential for stratigraphic traps
- Good source rock potential along continental margins



# Conclusions

- Contourites have the potential to provide good reservoir, seal and trapping mechanisms.
- Greater knowledge is required to distinguish from turbidites  
--> very different reservoir management applies
- Many prospective regions are located where contourites currently exist or are likely to have existed in the past!

