

# Diffraction imaging to understand the internal fabric of mass-transport complexes from Gulf of Cadiz, south west Iberian Margin

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Jonathan Ford (jford@inogs.it)<sup>1,3</sup> Roger Urgeles<sup>2</sup> Eulàlia Gràcia<sup>2</sup> Angelo Camerlenghi<sup>1</sup>

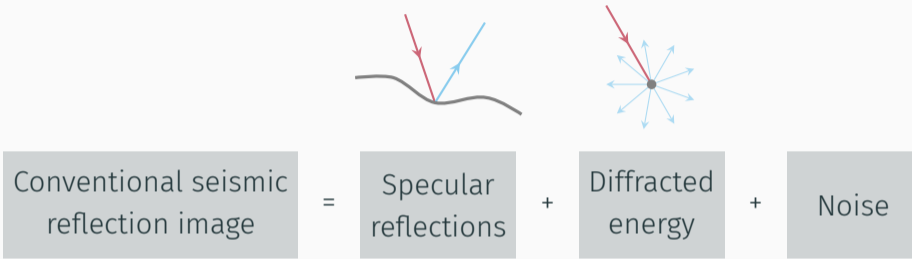
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<sup>2</sup>Institut de Ciències del Mar (ICM-CSIC)

<sup>3</sup>University of Trieste



# Model of the seismic wavefield



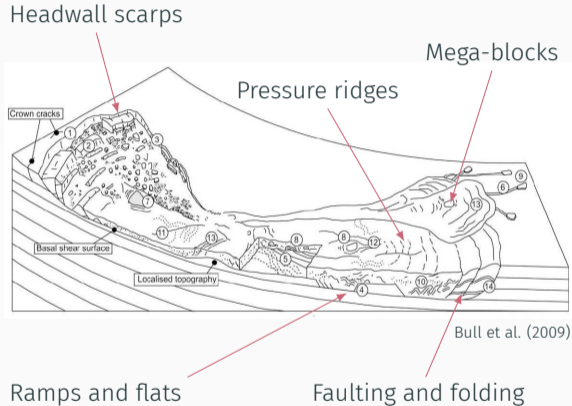
Before migration:



After migration:



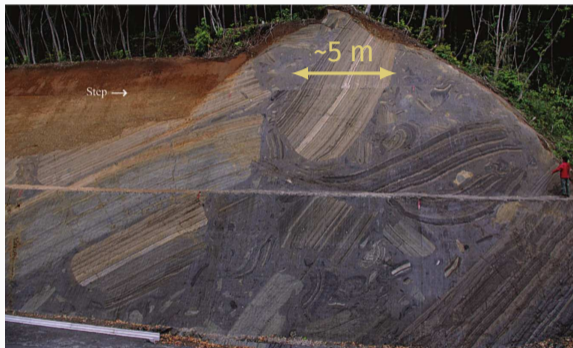
# Mass-transport complexes as diffraction generators?



## Requirements

- ✓ Impedance contrasts
- ✓ Lateral heterogeneity
- ✓ ...on the scale of the seismic wavelength (10s of m)

# Mass-transport complexes as diffraction generators?



Yamamoto et al. (2009)

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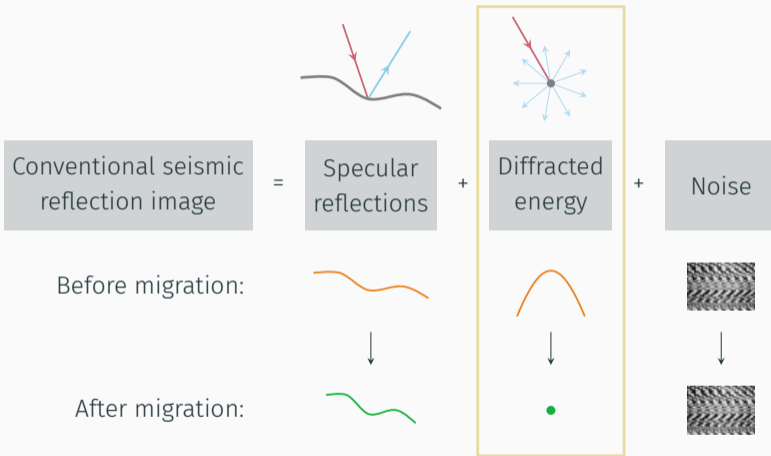
- ✓ Impedance contrasts
- ✓ Lateral heterogeneity
- ✓ ...on the scale of the seismic wavelength (10s of m)

Apply diffraction separation and imaging to seismic images of mass-transport complexes:

1. Do MTCs generate significant diffraction energy?
2. Can we use this to image internal structure?
3. Do we resolve things we cannot see in conventional images?

Ford, J., Urgeles, R., Gràcia, E., Camerlenghi, A. (in prep). *Diffraction imaging to understand the internal fabric of mass-transport complexes: examples from Gulf of Cadiz, south west Iberian Margin*

# Diffraction imaging



**Principle:** separate reflected and diffracted wavefields, migrate the diffractions

 Only to form a diffraction image

# INSIGHT cruises (May 2018 and October 2019)

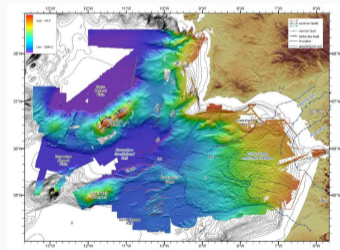
## INSIGHT

Imaging large seismogenic and tsunamigenic structures of the Gulf of Cadiz with ultra-high resolution technologies

- PIs: Roger Urgeles and Eulàlia Gràcia
- Acquisition: “2-D HR”, 350 m streamer, 930 cu. in. airgun array



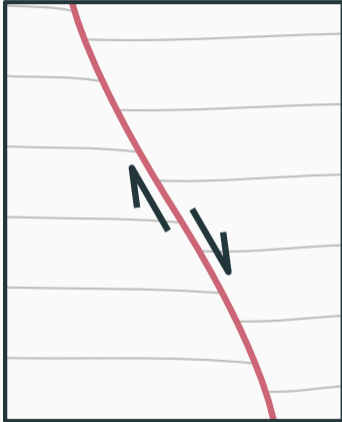
B/O Sarmiento de Gamboa



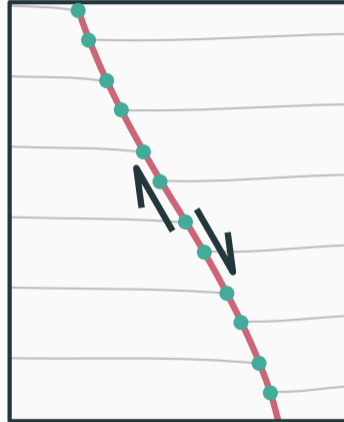
Gulf of Cadiz (Urgeles, 2019)

# Diffraction separation and imaging (normal fault example)

Reflectors



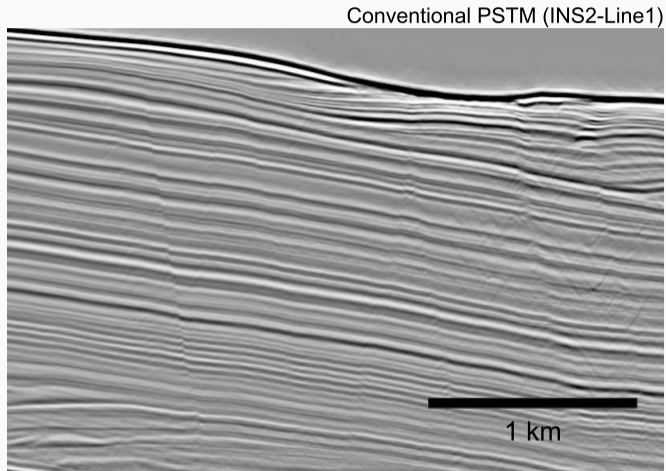
Diffractors





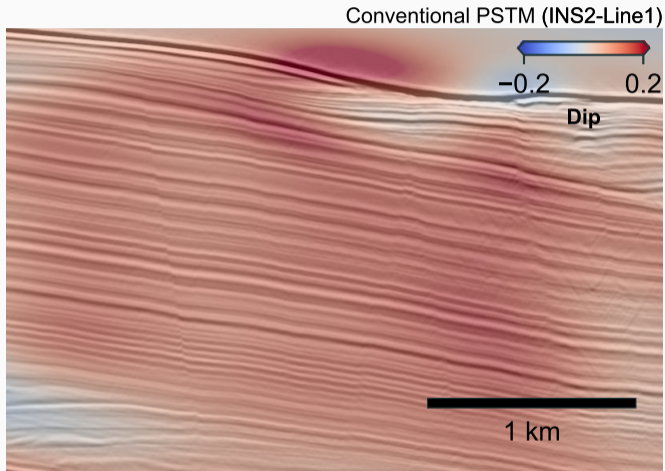
# Diffraction separation and imaging (normal fault example)

- Conventional pre-stack time migration
- Dip estimation
- De-migrate dip (Ford et al., in prep)
- Diffraction separation (offset domain plane-wave destruction; Fomel et al., 2007)
- Pre-stack time migration of diffractions



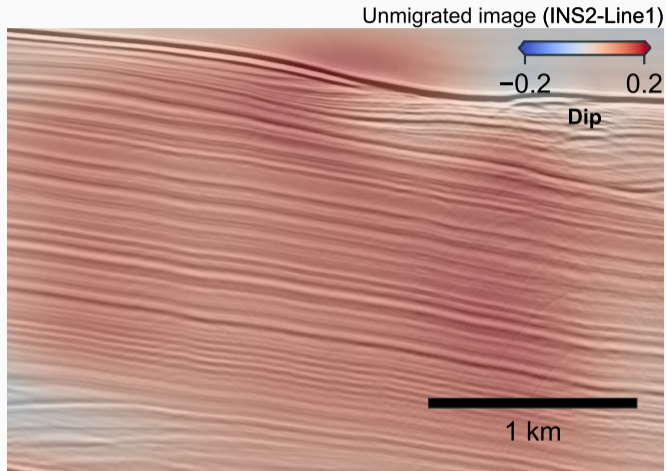
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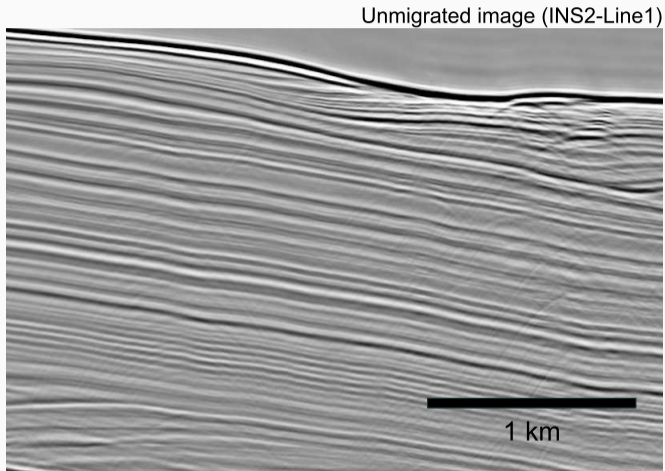
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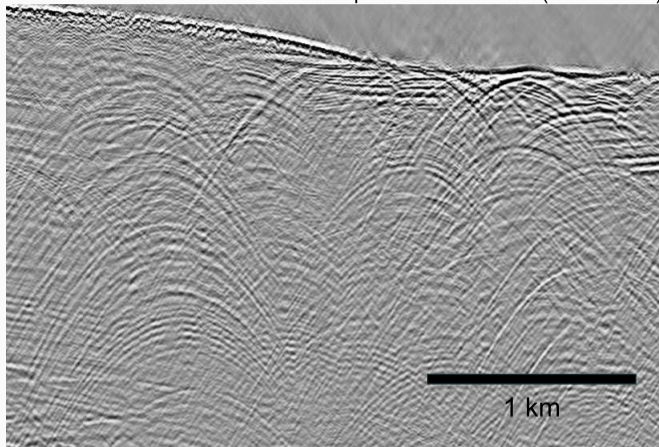
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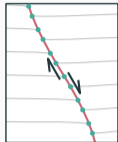
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Separated diffractions (INS2-Line1)

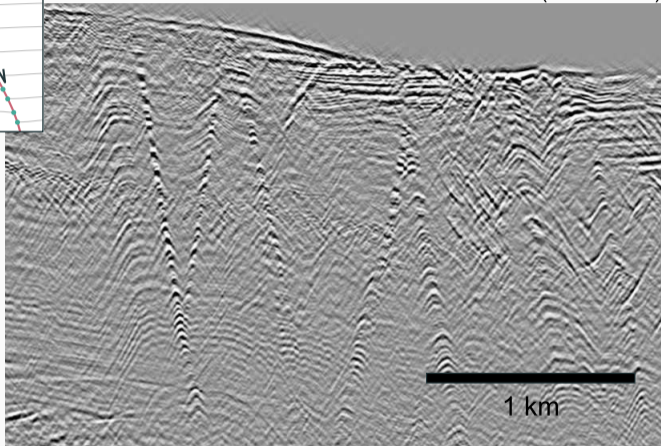


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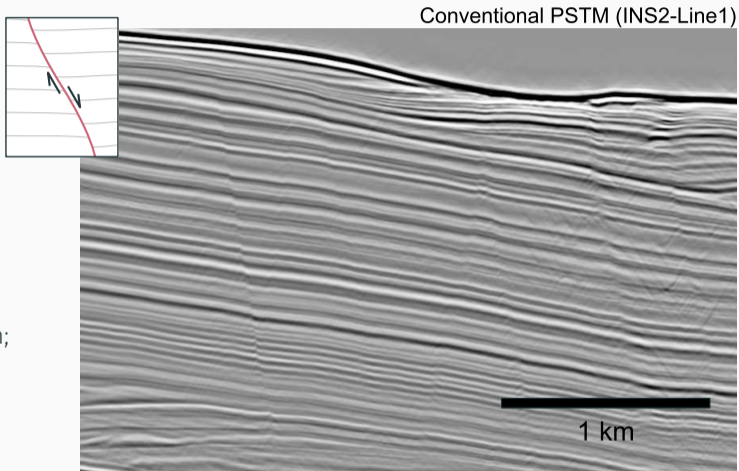


Diffraction PSTM (INS2-Line1)



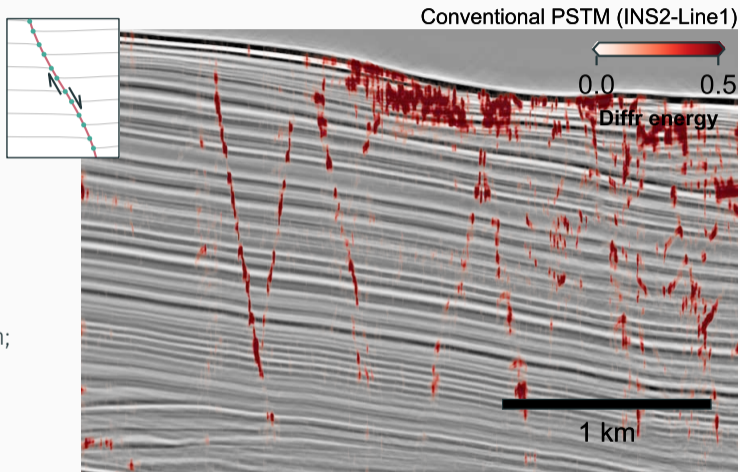
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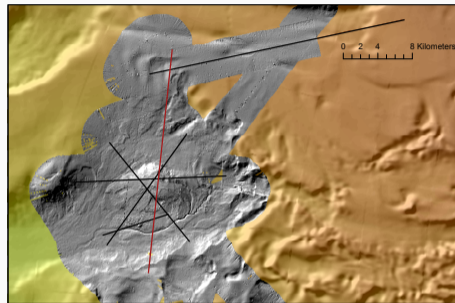
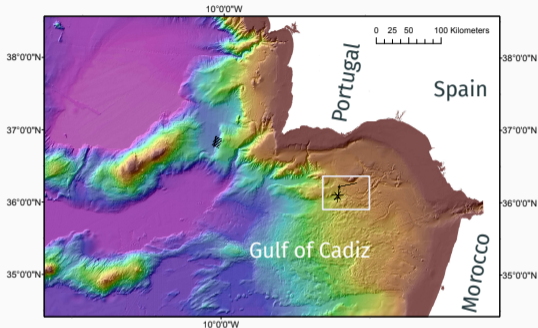
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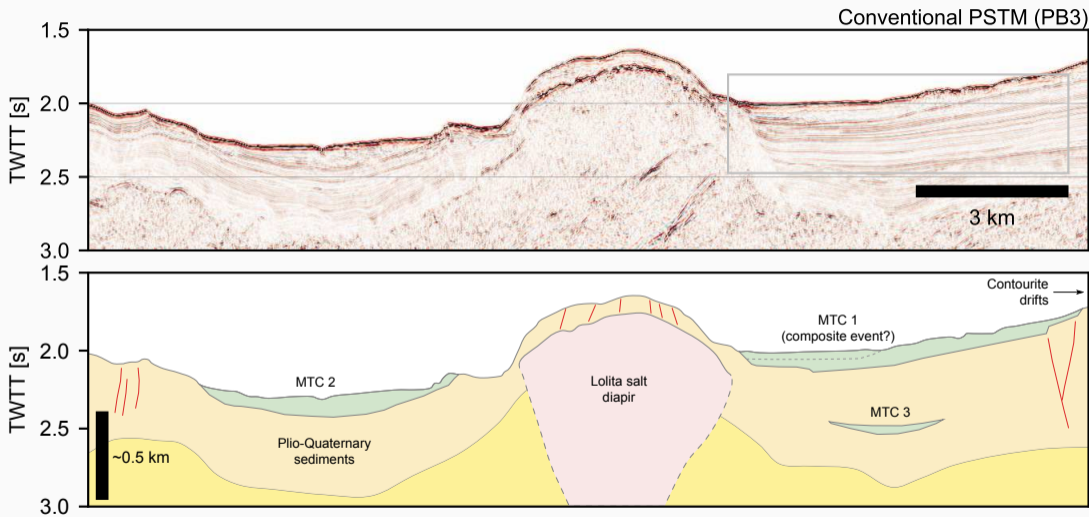


# Portimao Bank – Lolita salt diapir

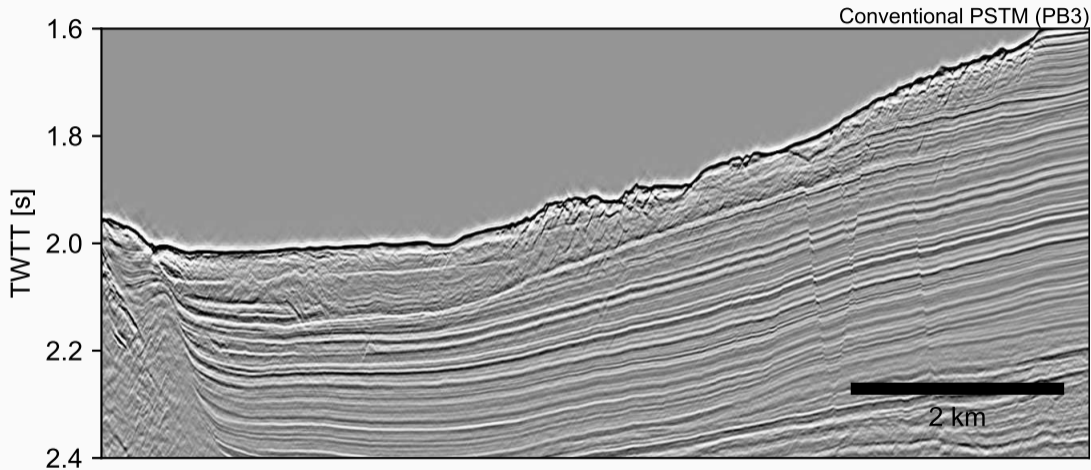


**Geological setting:** extensive contouritic deposits (from Mediterranean Outflow Water), salt diapirism = mass-wasting

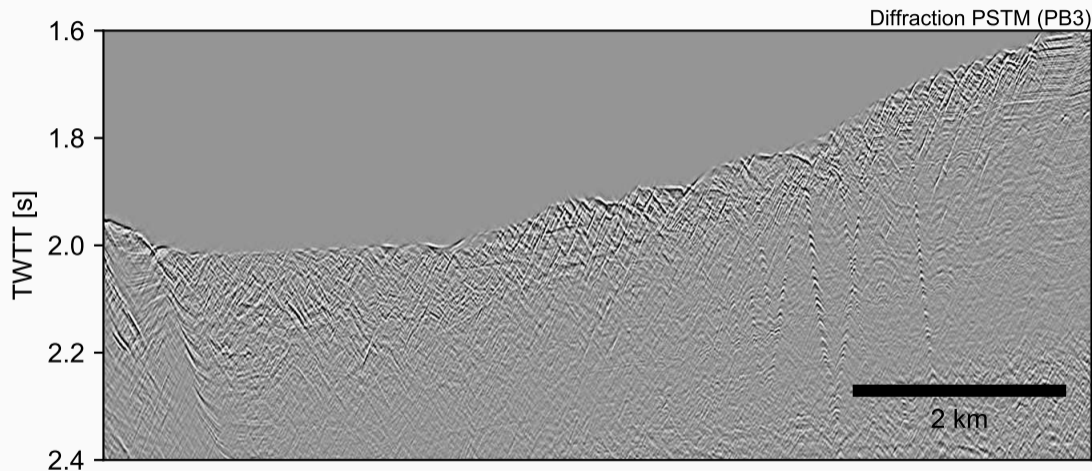
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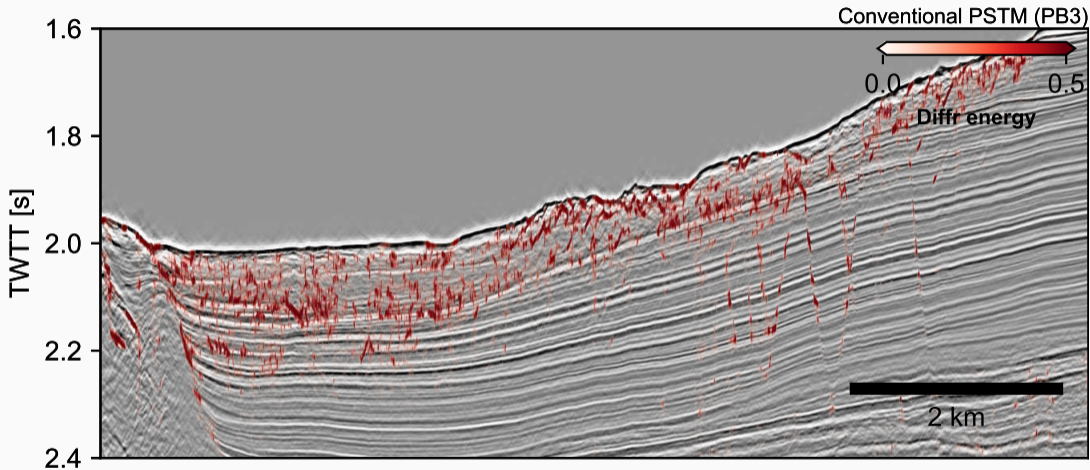
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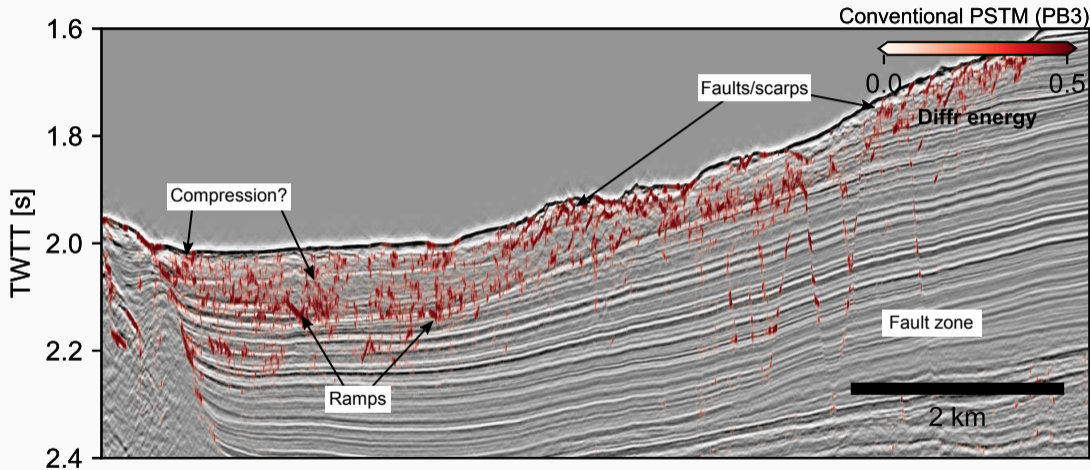
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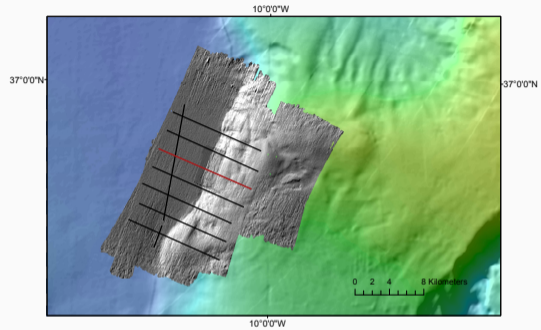
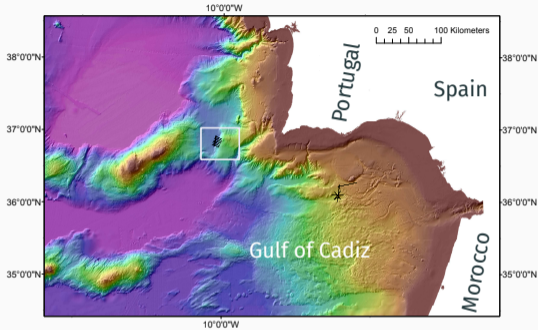
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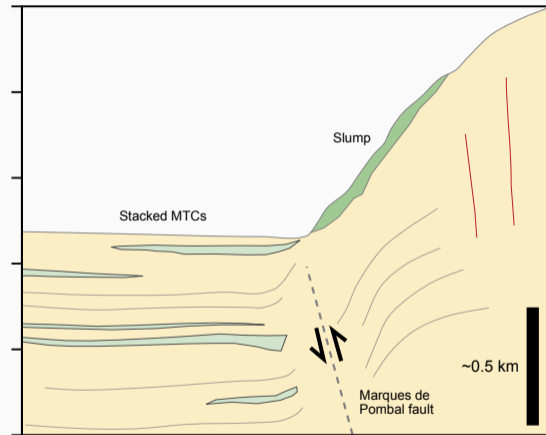
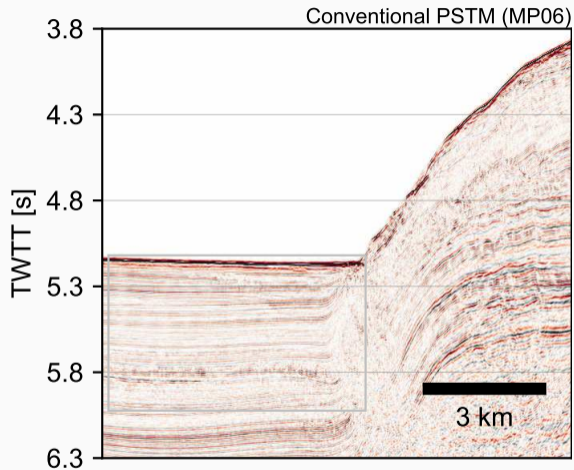
# Marques de Pombal Fault



## Geological setting:

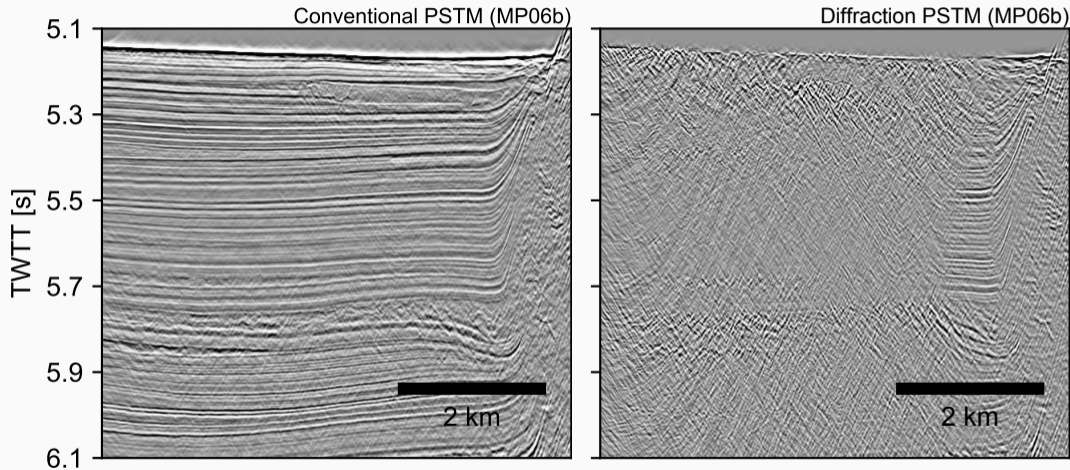
- Monoclinical thrust cutting the Plio-Quaternary (potential source of 1755 Lisbon earthquake + submarine landslide + tsunami; Zitellini et al., 2001)
- Thick succession of MTCs in basin – record fault activity?

# Marques de Pombal Fault



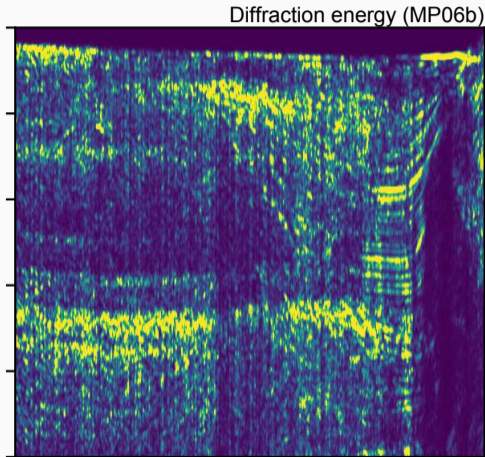
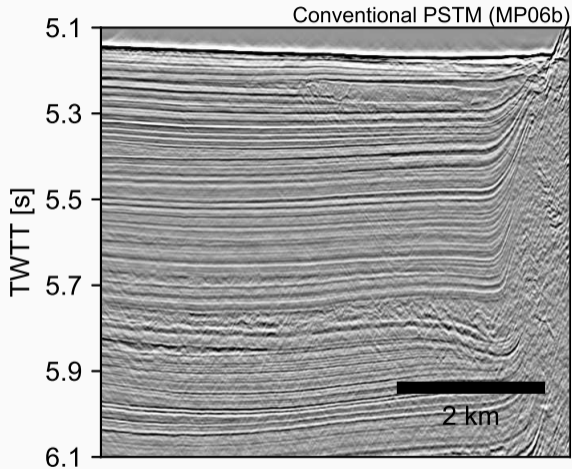


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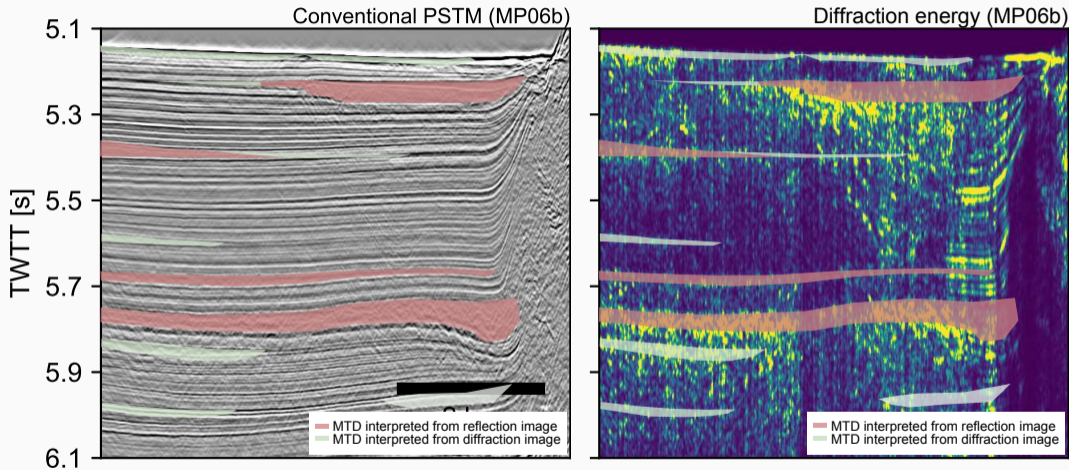
Identify small MTCs ( $<$ a wavelet thick), better constraint of lateral extent

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Identify small MTCs ( $< a$  wavelet thick), better constraint of lateral extent

# Diffraction imaging (old) applied to image mass-transport complexes (new)

## Applications:

- Screening for MTCs, delimiting lateral extent (energy attribute)
- Kinematic indicator from distribution of diffraction energy – sensitive to downslope disaggregation of flow?
- Resolve structure inside “transparent” bodies

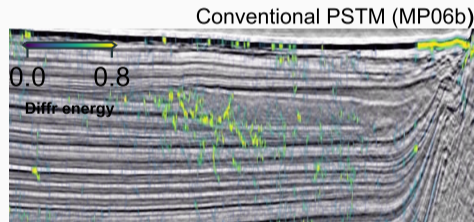
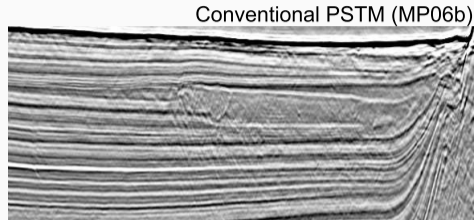
## Limitations:

- Out-of-plane energy on 2-D profiles (3-D effect of MTCs)
- Seismic processing – care needed to preserve diffractions, avoid aliasing
- Noise

**Note:** works on short-offset and post-stack data (also for velocity model building)

# Conclusions

1. MTCs do produce lots of diffraction energy, relative to unfailed sediments
2. Diffraction image is sensitive to heterogeneous structure inside MTCs
3. New tool to characterise MTCs
  - Image heterogeneous internal structure
  - Screen for thin bodies



# Acknowledgements and references

Thanks to the crew, technicians and science party of INSIGHT (Leg 1 and 2) cruises, particularly the onboard MCS processing group: E. Piazza, R. Bartolomé, P. Brito and A. Calahorrano

Diffraction separation and imaging was performed using Madagascar (<http://reproducibility.org>)



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