

Geotechnics for Offshore Wind

Setting the scene – Phil Watson

A developer's perspective of geotechnics for offshore wind – Elisabeth Palix

An overview of 'new' challenges facing offshore wind – Zack Westgate

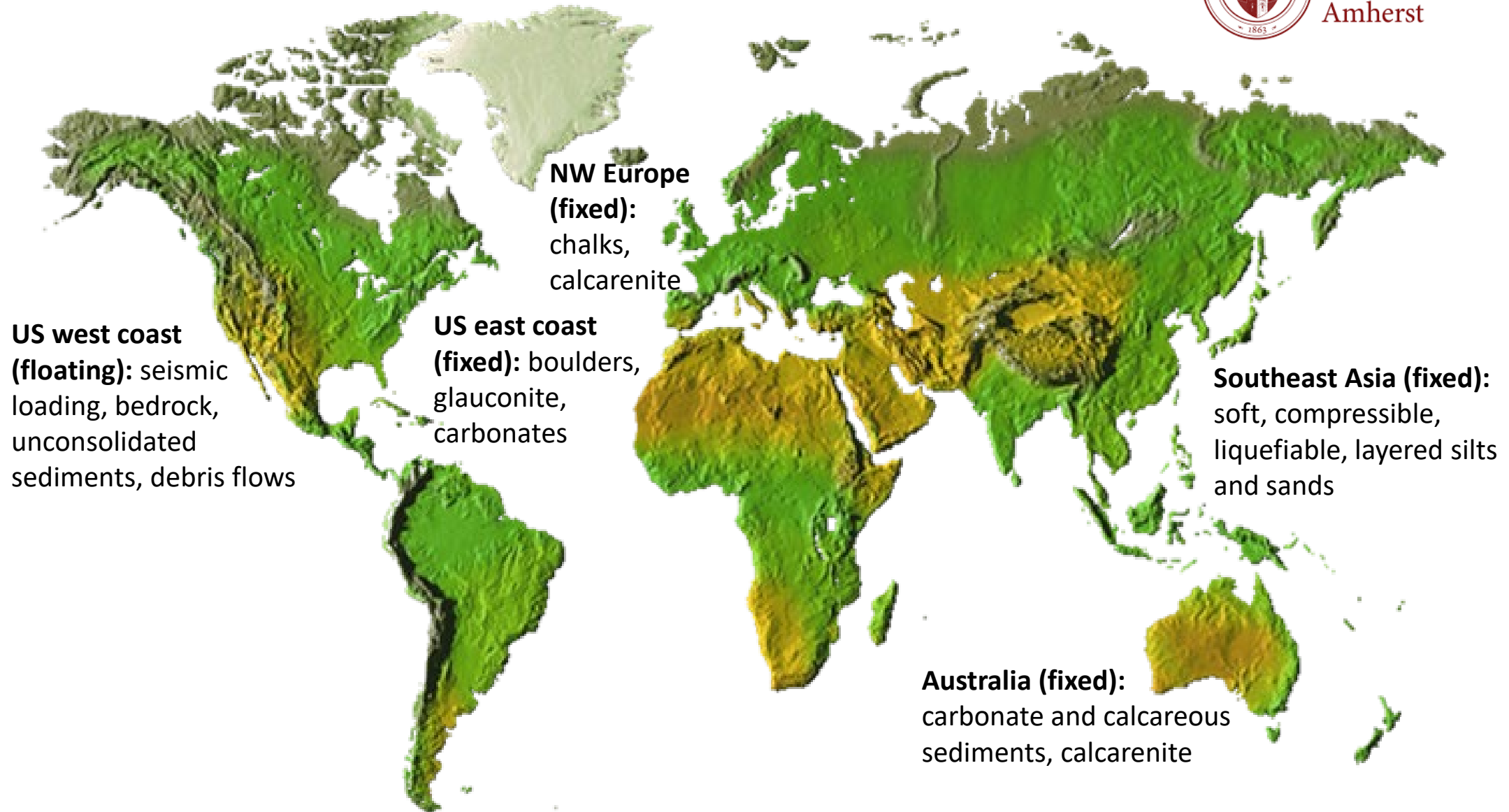
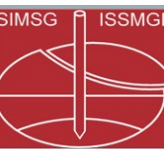
Geotechnical research to support offshore wind – Christelle Abadie

Close – Phil Watson

New challenges facing offshore wind



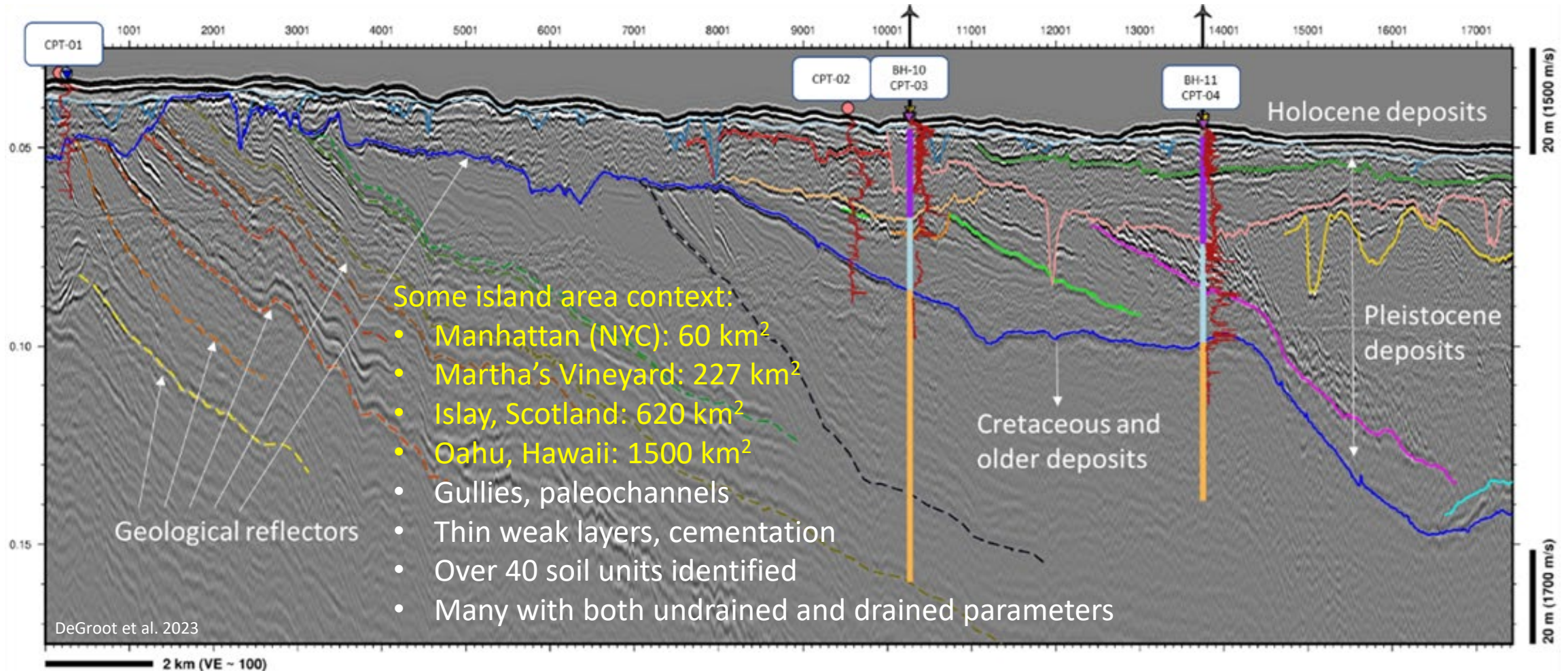
University of
Massachusetts
Amherst



New challenges facing offshore wind

“Site” characterization: a global challenge

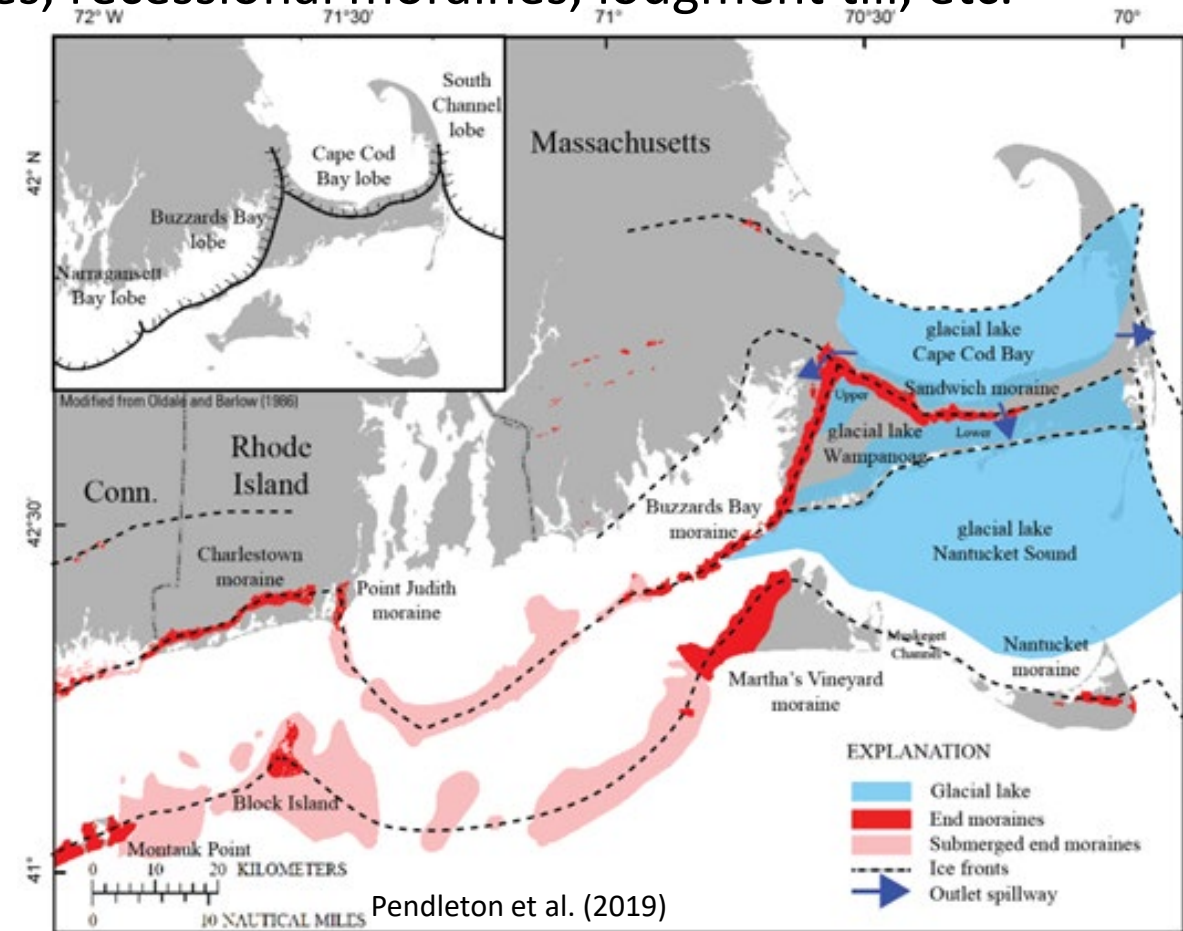
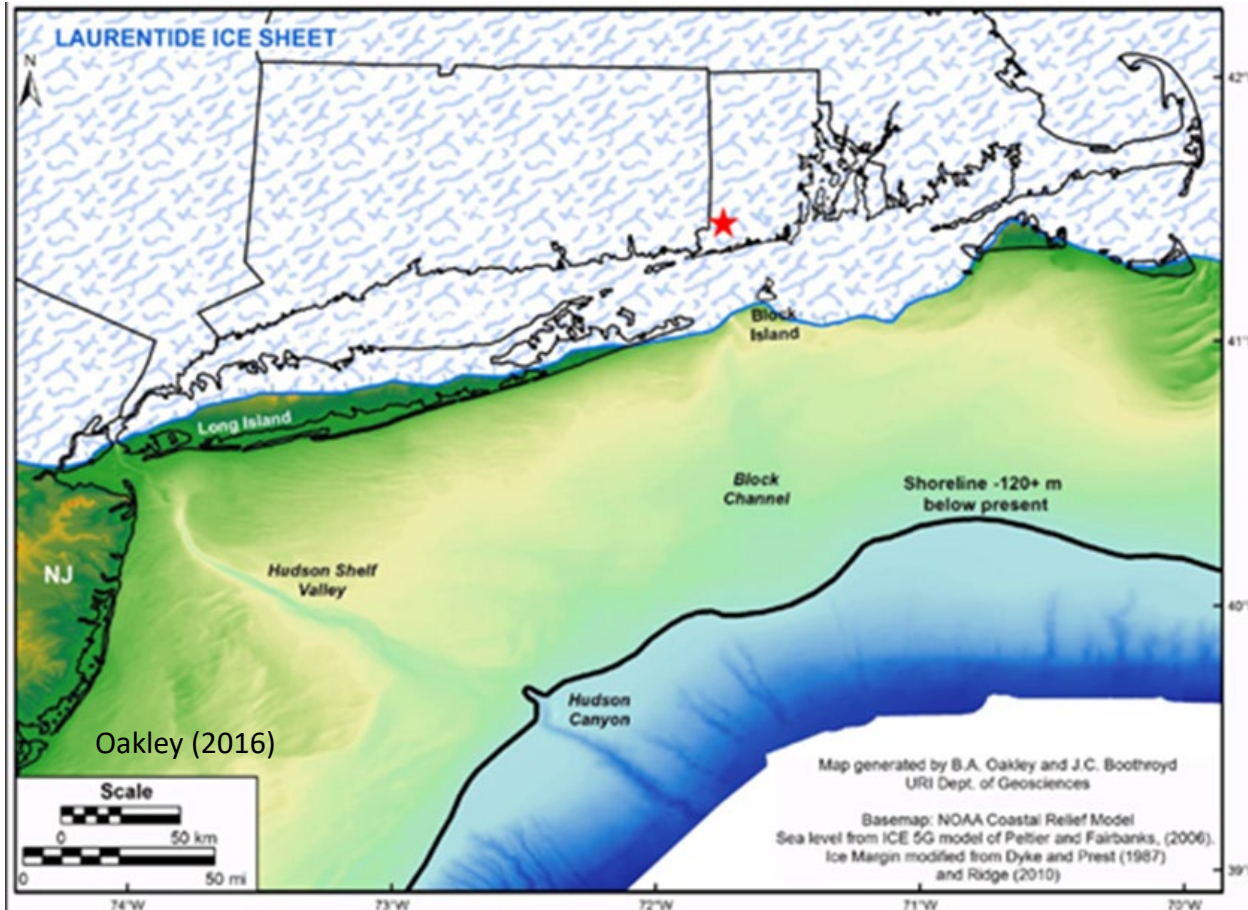
Massive areas ($\gg 100 \text{ km}^2$), lots of spatial variability, increasing sense of urgency (2-3 years of SI)



New challenges facing offshore wind

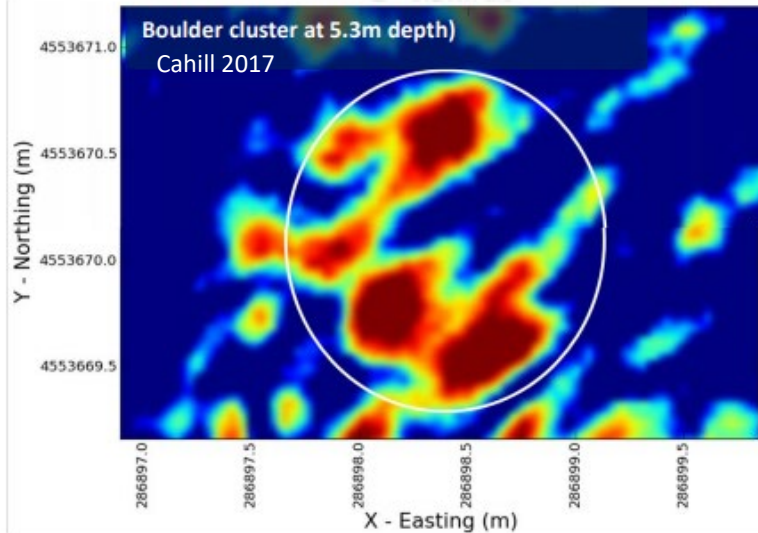
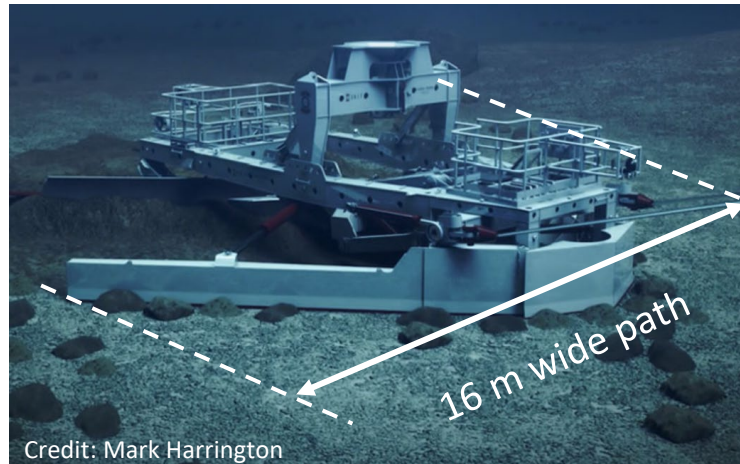
Glacial geology and changing sea levels

- Changing sea level: US East Coast low sea level stand ~ 120m below present-day
- Glacial retreat: glacial outwash, terminal moraines, recessional moraines, lodgment till, etc.

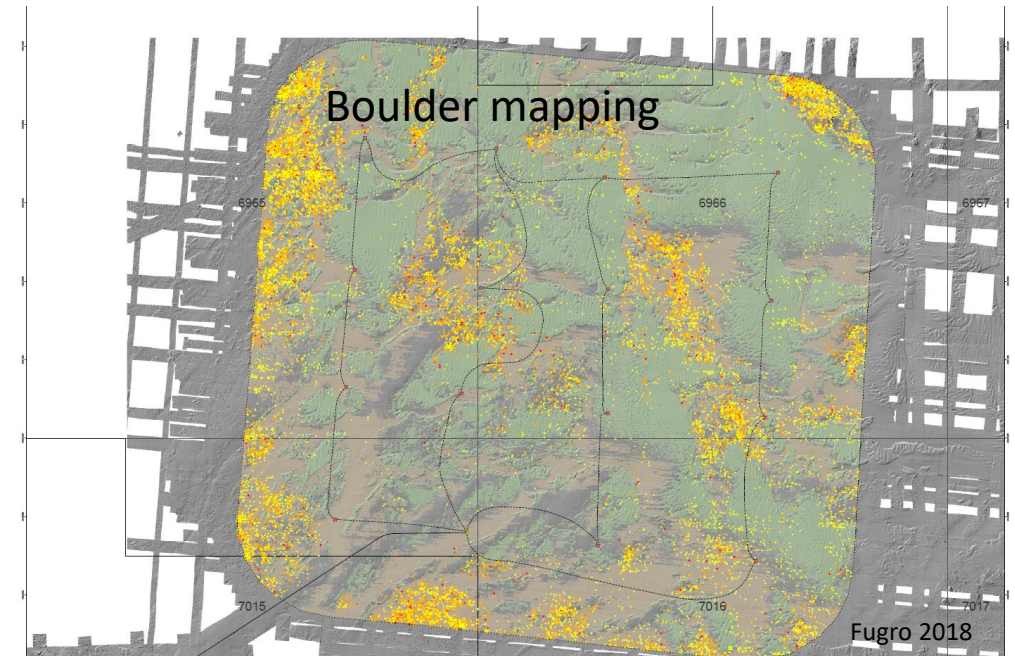


New challenges facing offshore wind

Boulders



- Deposited at terminal moraines
- Shallow and/or deep deposits
- Generally 1 to 6 m diameter, up to 15 m
- Risks: Pile buckling, cable trenching
- Mitigations: micrositings, removal

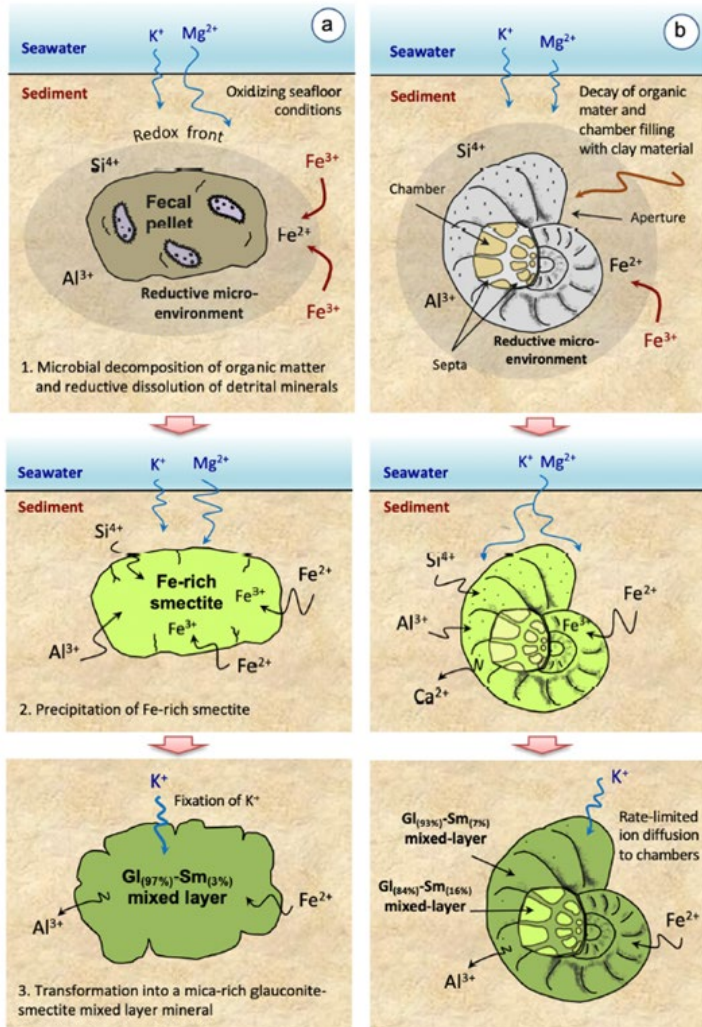


New challenges facing offshore wind

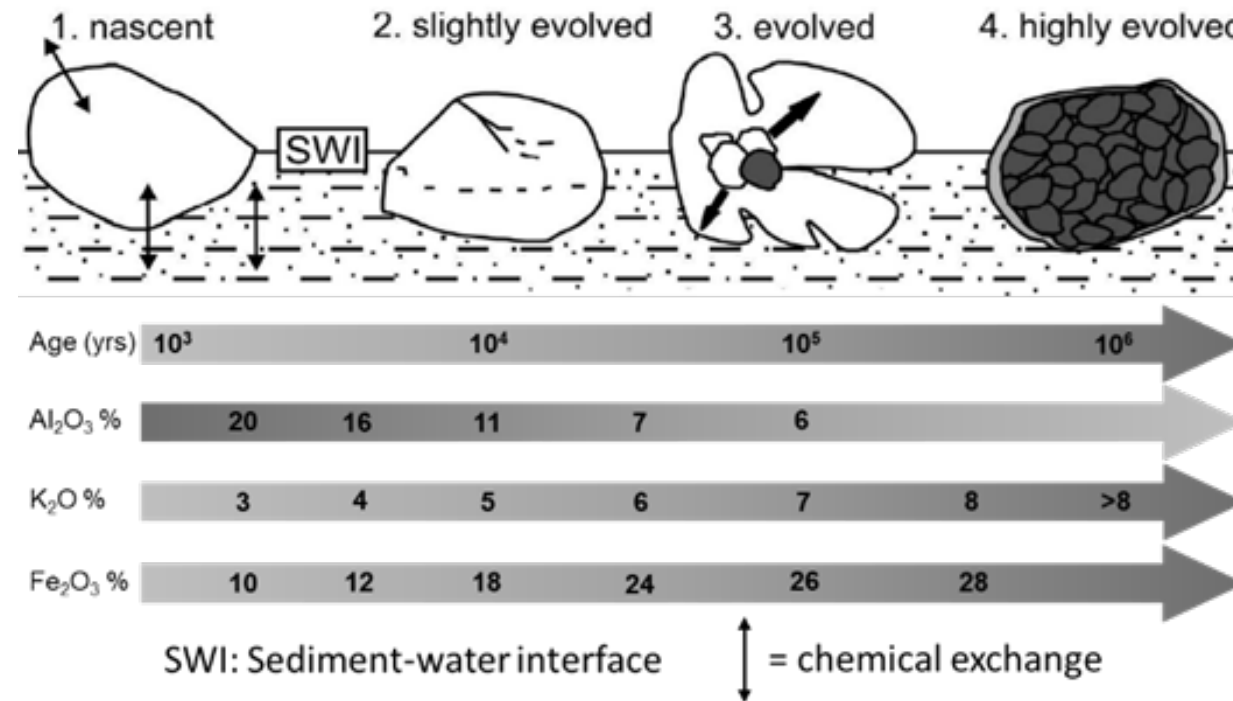
Glaucinite sand – what is it?



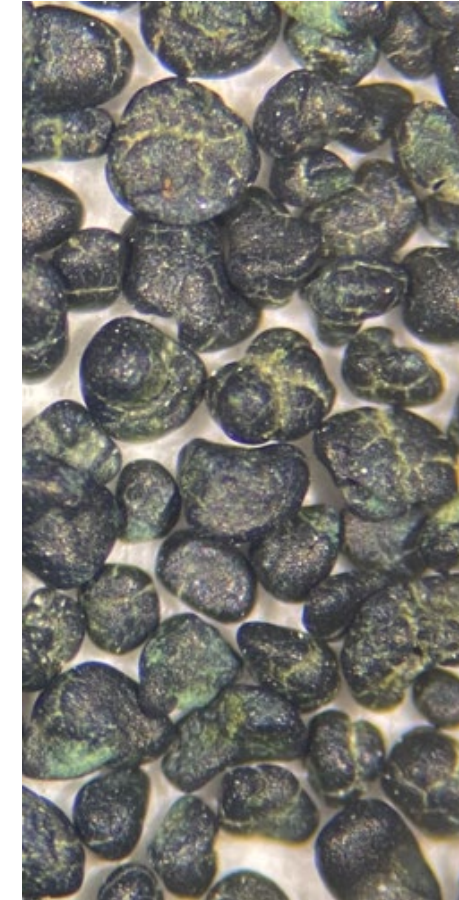
- iron rich potassium mica of illite clay family
- glaucony (morphological) vs glauconite and glauconitic (mineralogical)
- magnetic with high specific gravity (~ 3)
- authigenic (in situ) vs allogenic (reworked)



Fernández-Landero and Fernández-Caliani (2021)

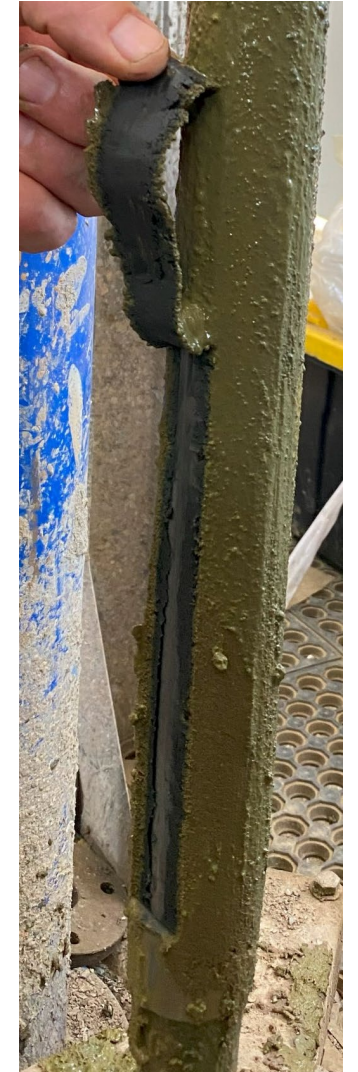


Westgate et al. (2023); after Obasi et al. (2011); López-Quirós et al. (2019)



New challenges facing offshore wind

Glaucinite sand – how can we identify it?

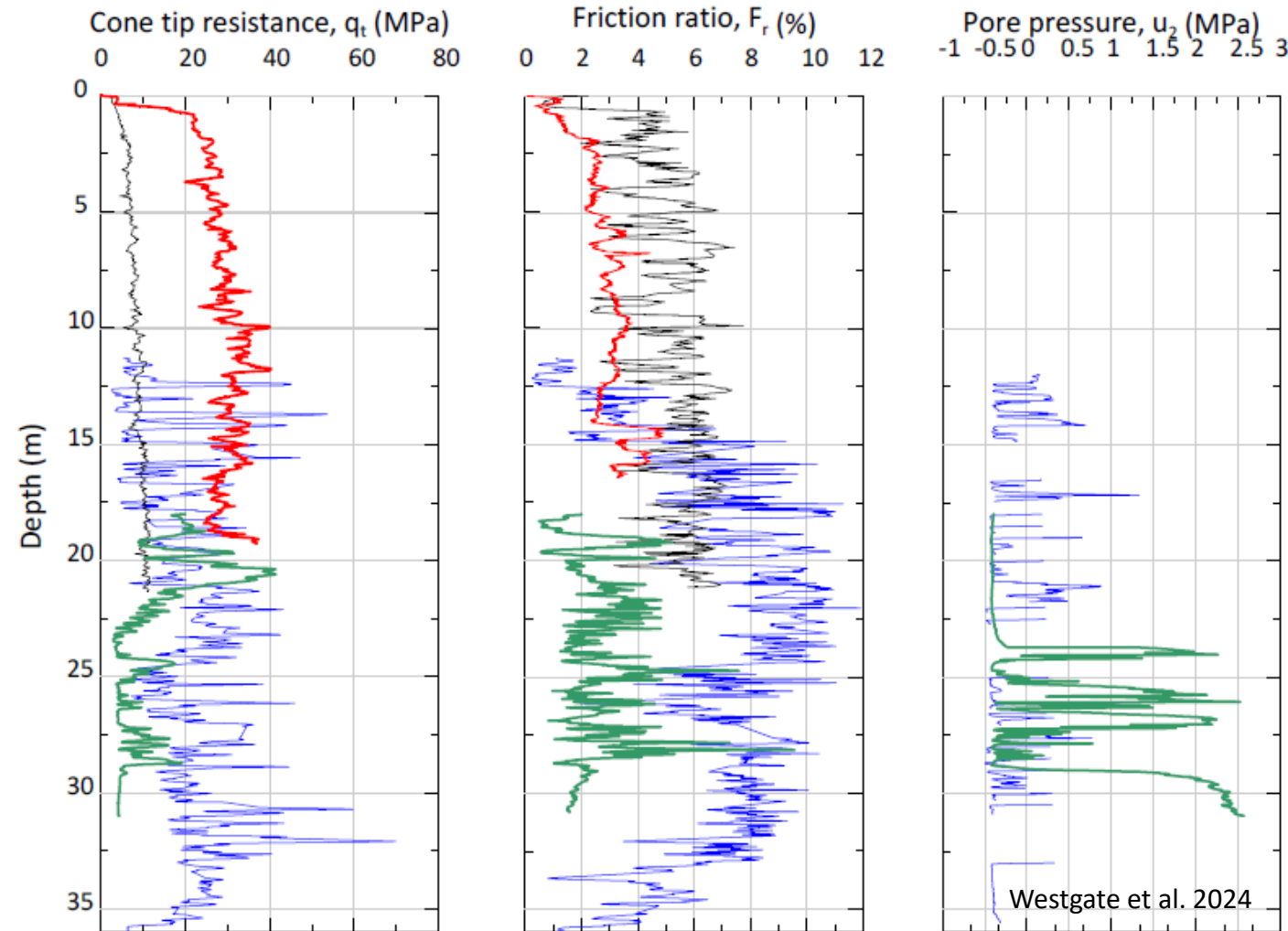


CPT Identification:

- high q_t
- high F_r
- cavitation u_2
- or high positive u_2
- rod 'smears'

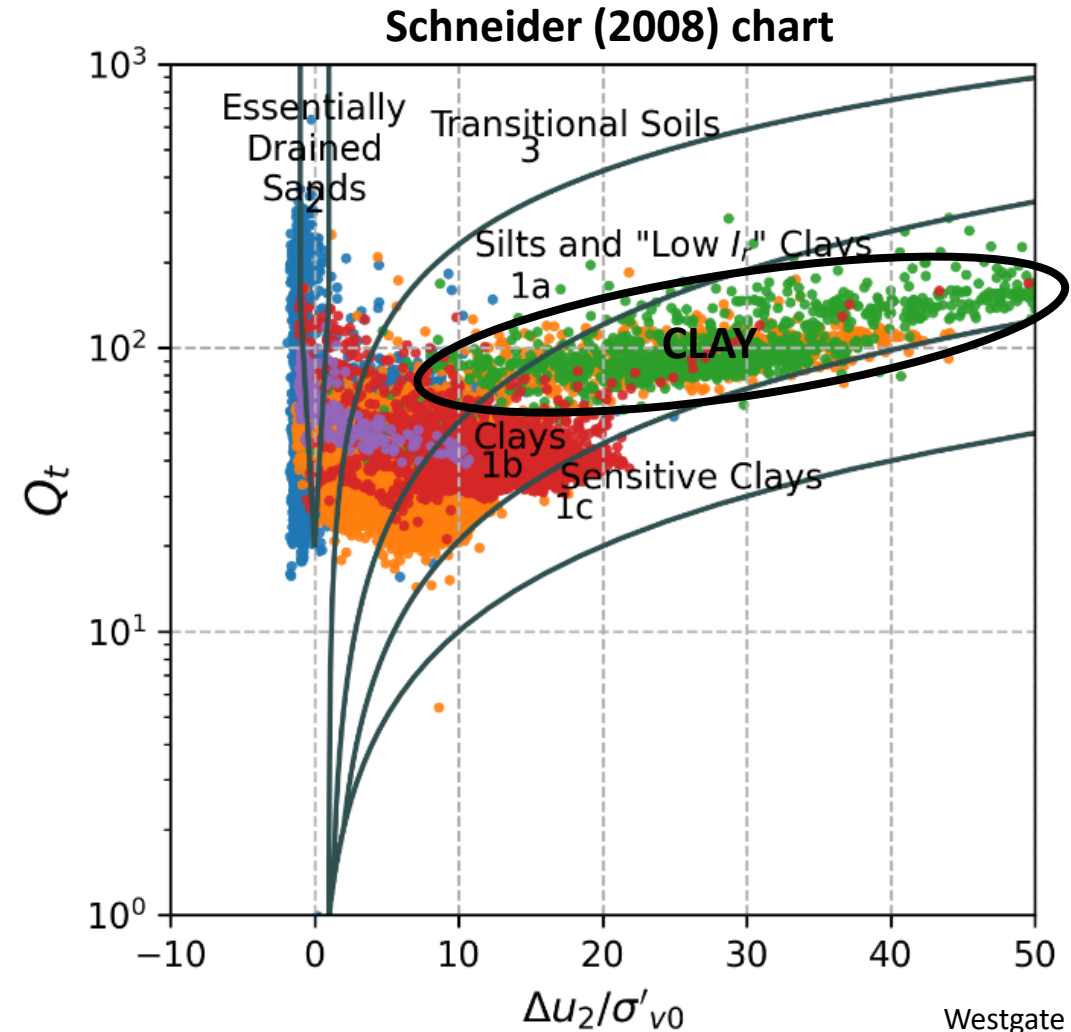
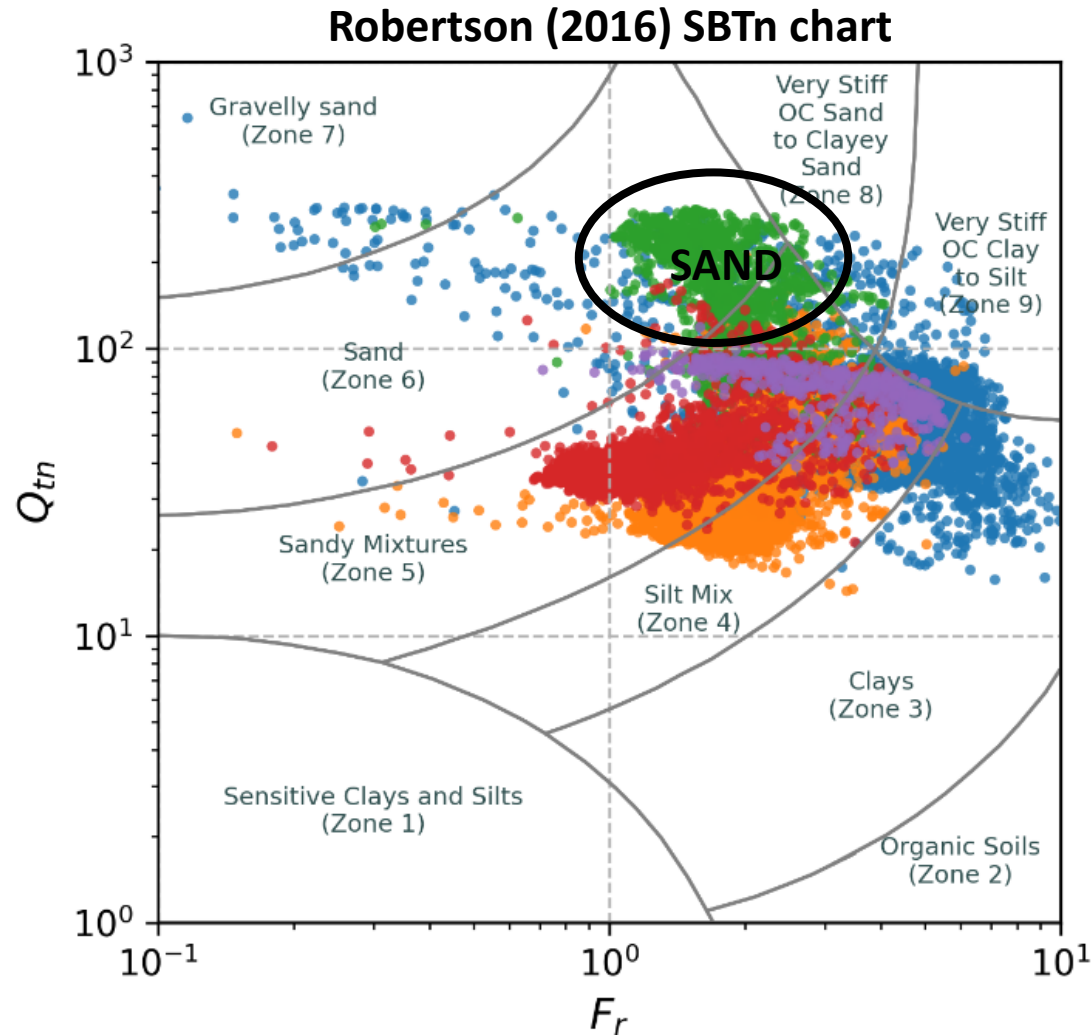
Laboratory Identification:

- authigenic typically higher % glauconite
- magnetic separation
- XRD and XRF
- image analysis
- maturity based on K and Fe content



New challenges facing offshore wind

Glaucanite sand – SBT: misleading CPTs?



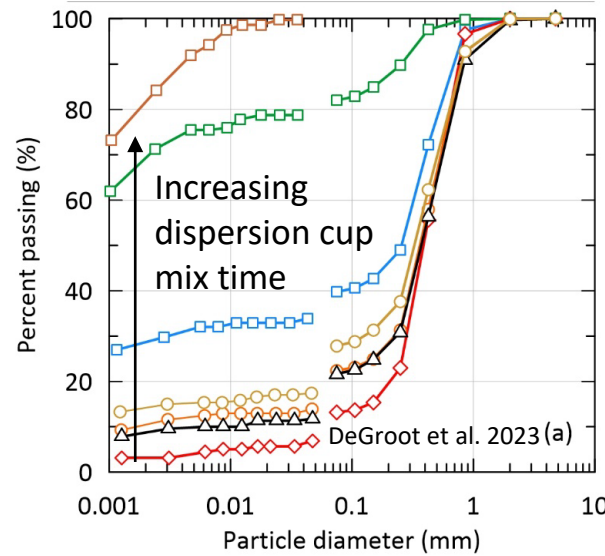
Westgate et al. 2024

New challenges facing offshore wind

Glaucinite sand – pile driving effects



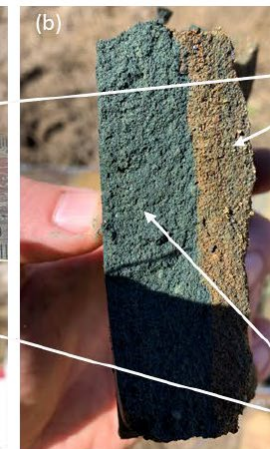
University of
Massachusetts
Amherst



PIGS JIP

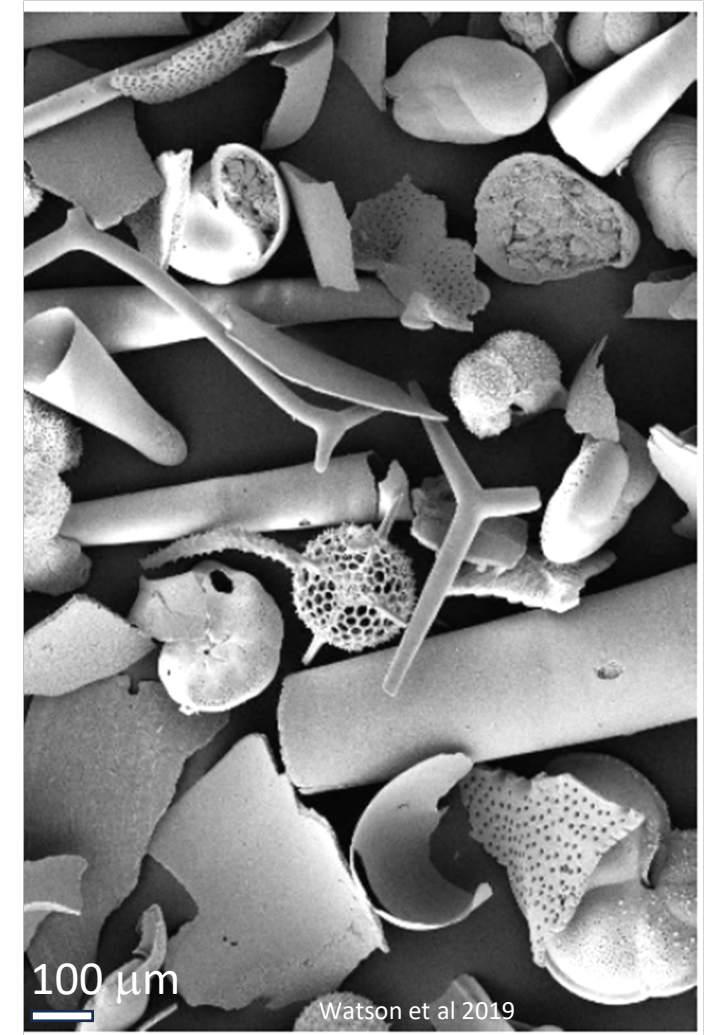
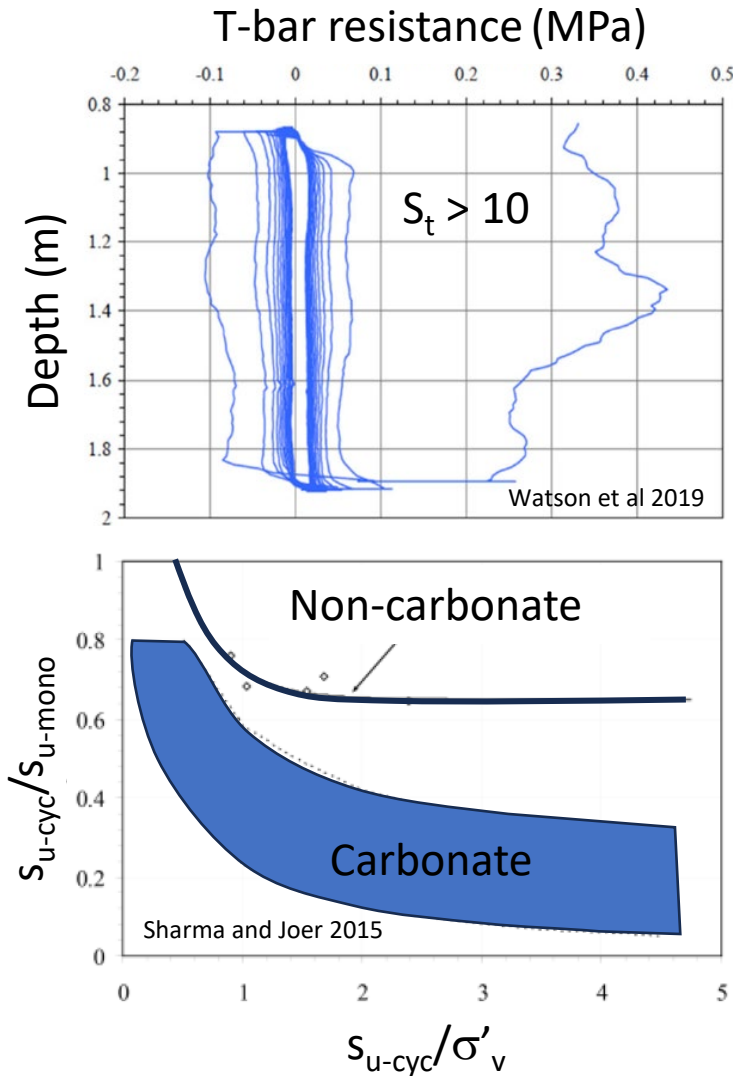
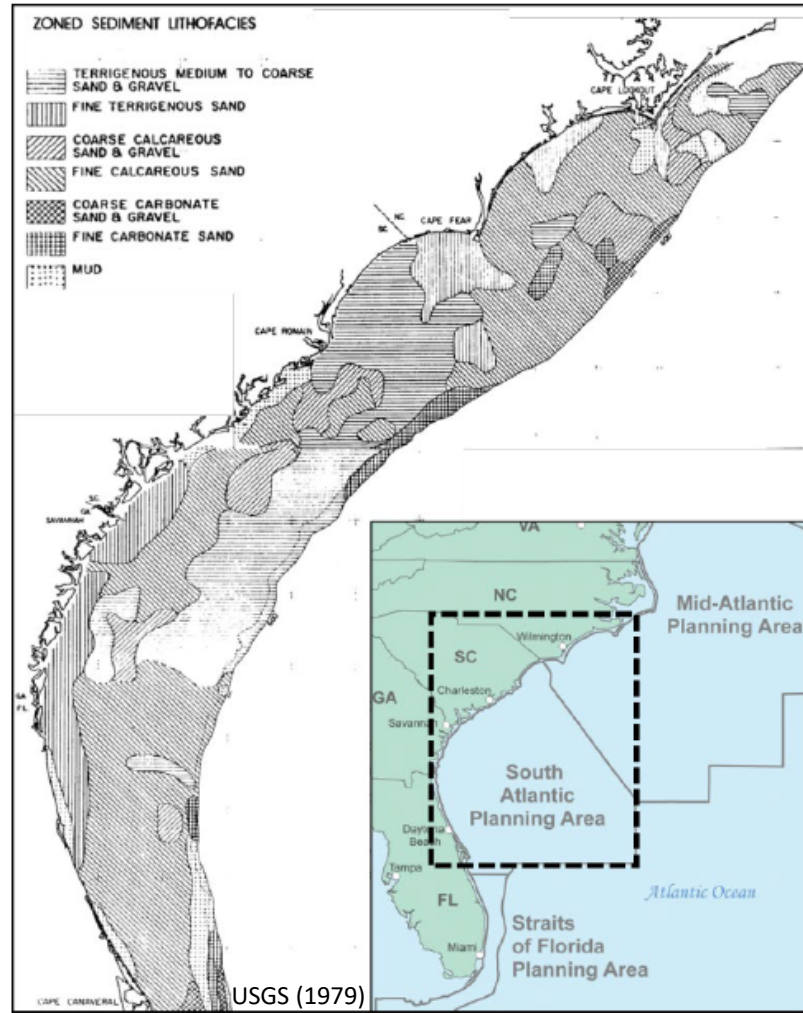
Piling In Glaucinitic Sand

NGI-led JIP at test site in New Jersey (UMass Amherst, Rutgers, U Arkansas, UMass Dartmouth)



New challenges facing offshore wind

Carbonate sediments

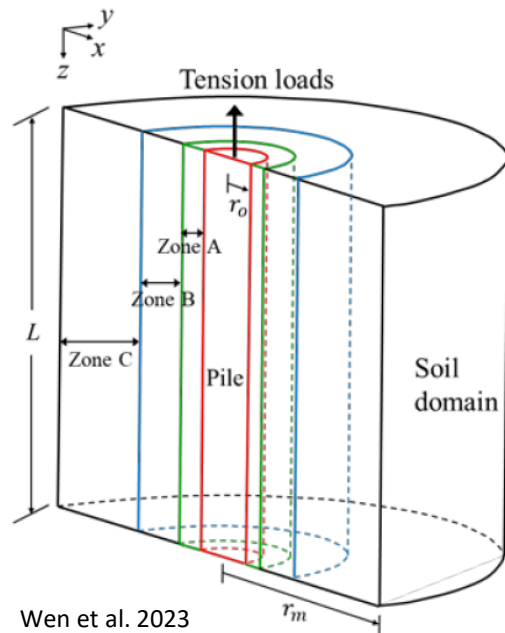


New challenges facing offshore wind

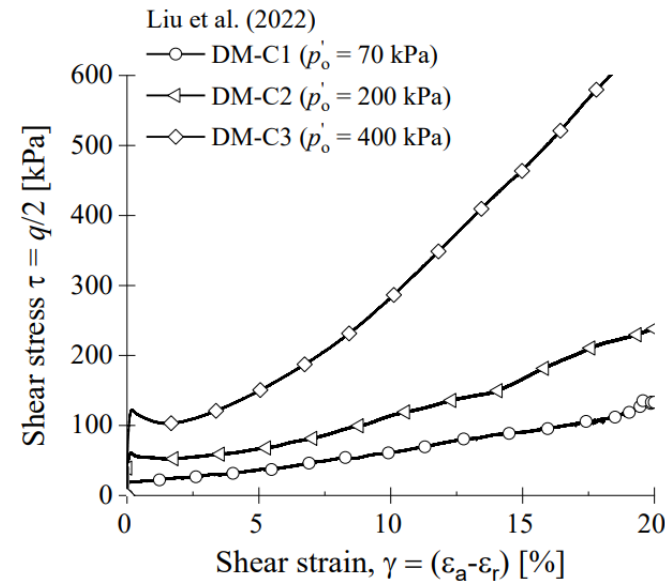
Chalk



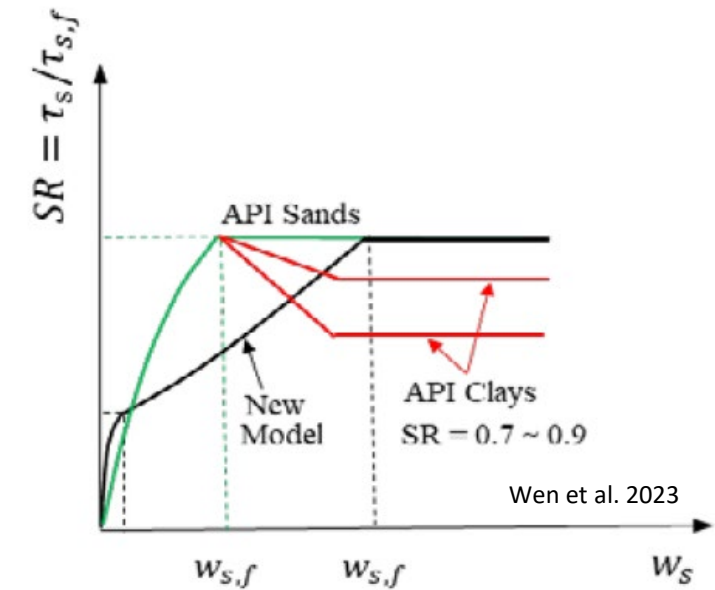
- Soft, high porosity chalks of low-medium density
- Highly sensitive paste-like material along shaft (Zone A)
- Fractures, loss of lateral stiffness (Zones B, C)
- Pile runs, long term axial and lateral capacity challenges
- JIPs: Innovate-UK JIP (axial), ALPACA JIP (lateral field), ALPHA (lateral 3DFE)



Wen et al. 2023

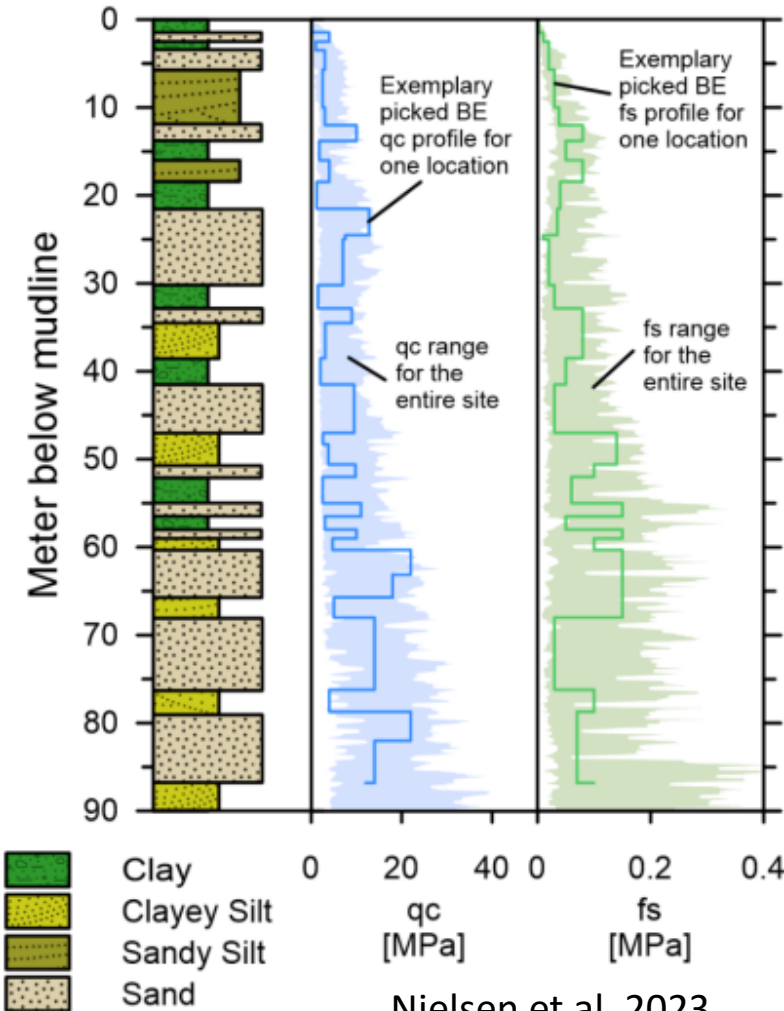
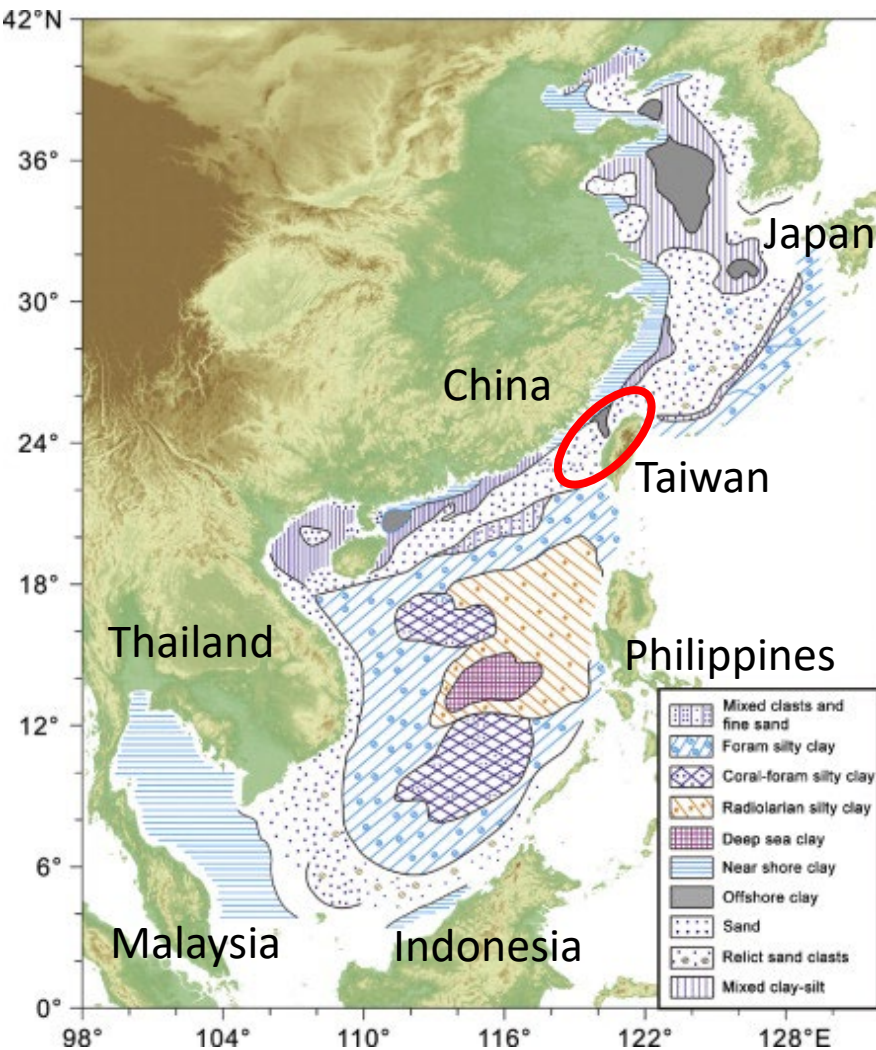


Vinck 2021



New challenges facing offshore wind

Free falling piles



Nielsen et al. 2023

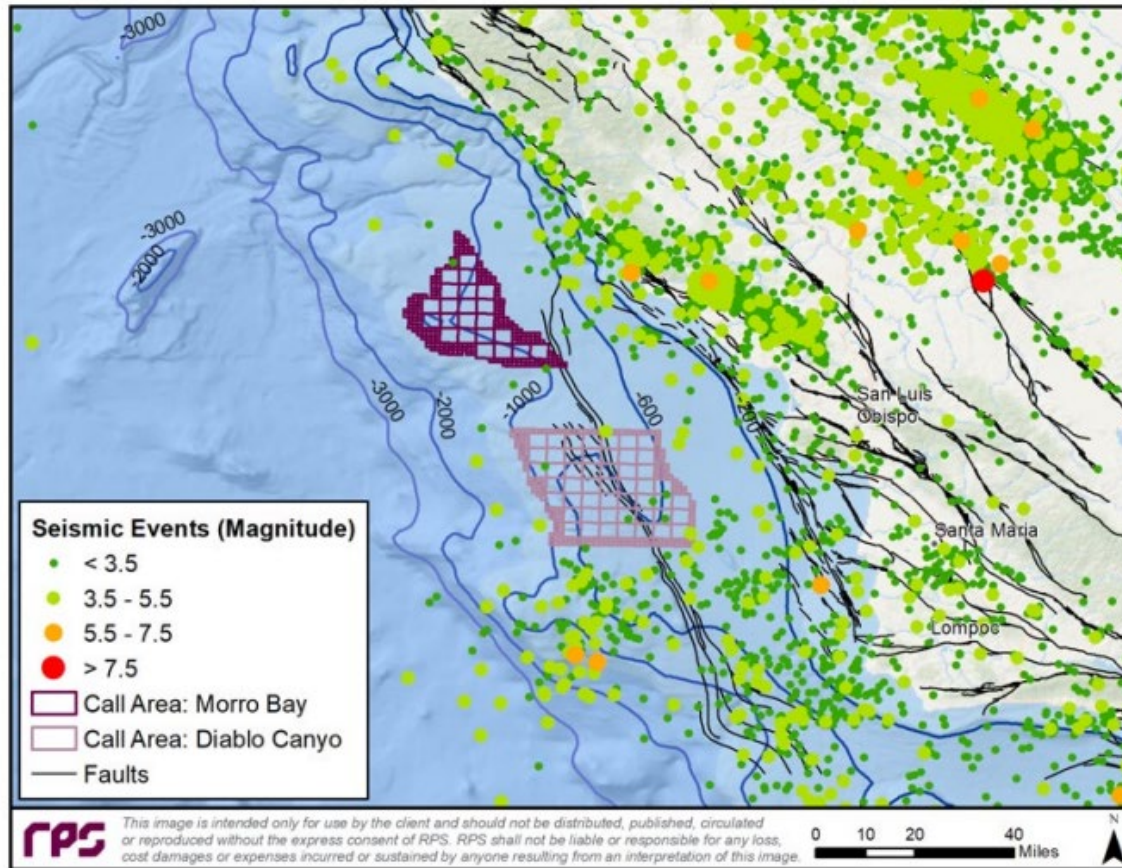
- Multiple incidents over past few years
 - Thrice on one project
- Soft, compressible soil?
 - check
- Weak layers?
 - check
- Potential liquefaction?
 - check
- Long, heavy monopiles?
 - check
- Poor site characterization?
 - Depends on who you ask!

New challenges facing offshore wind

Deep water geohazards: high seismicity

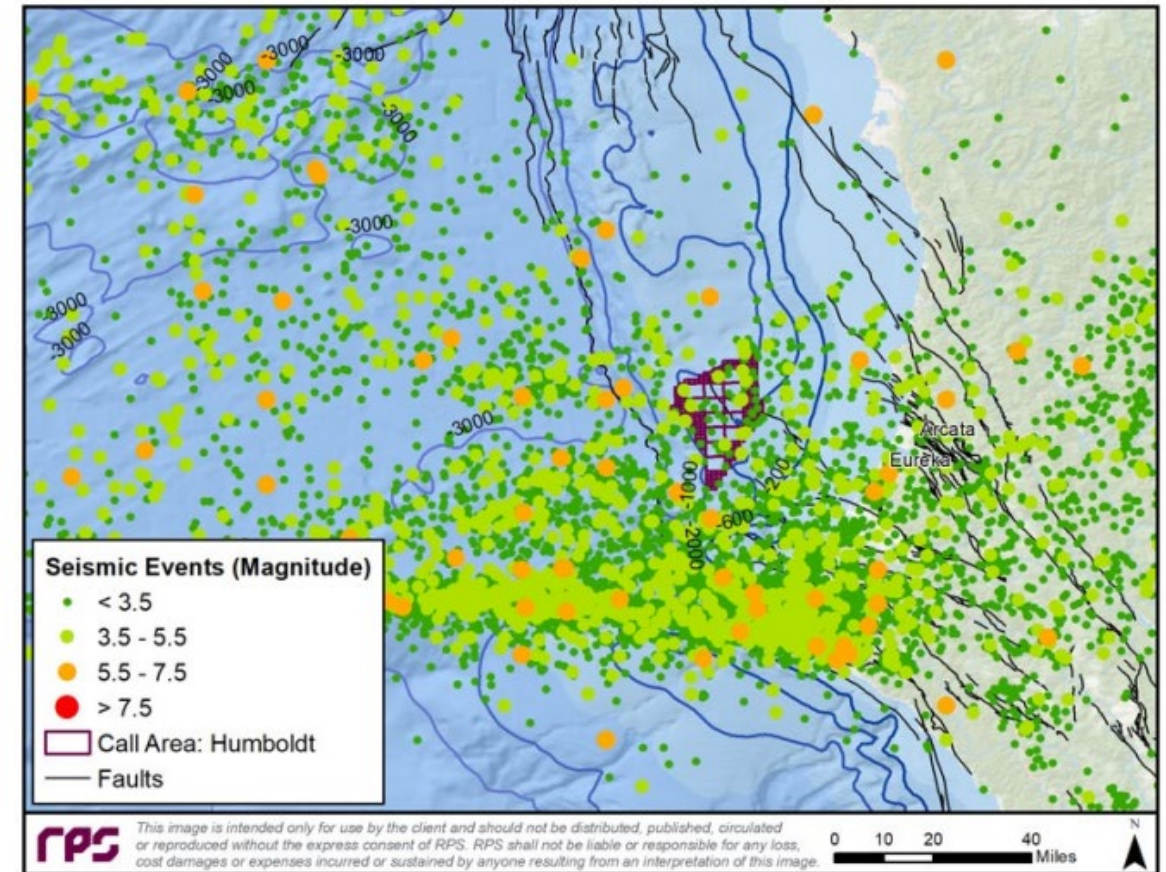
Morro Bay, Diablo Canyon Call Areas:

- San Andreas Fault

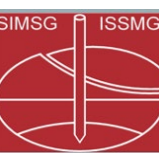


Humboldt Call Area:

- Cascadia Subduction Zone



University of
Massachusetts
Amherst

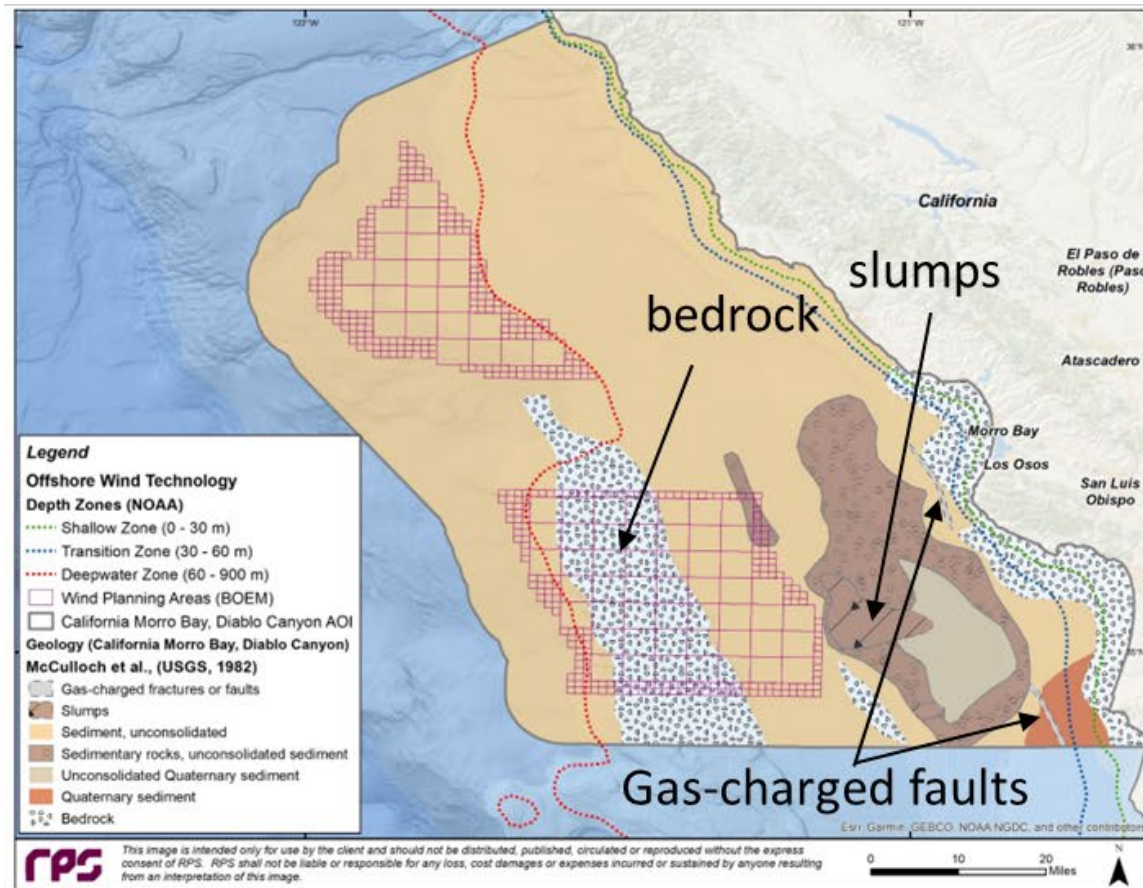


New challenges facing offshore wind

Deep water geohazards: seabed conditions

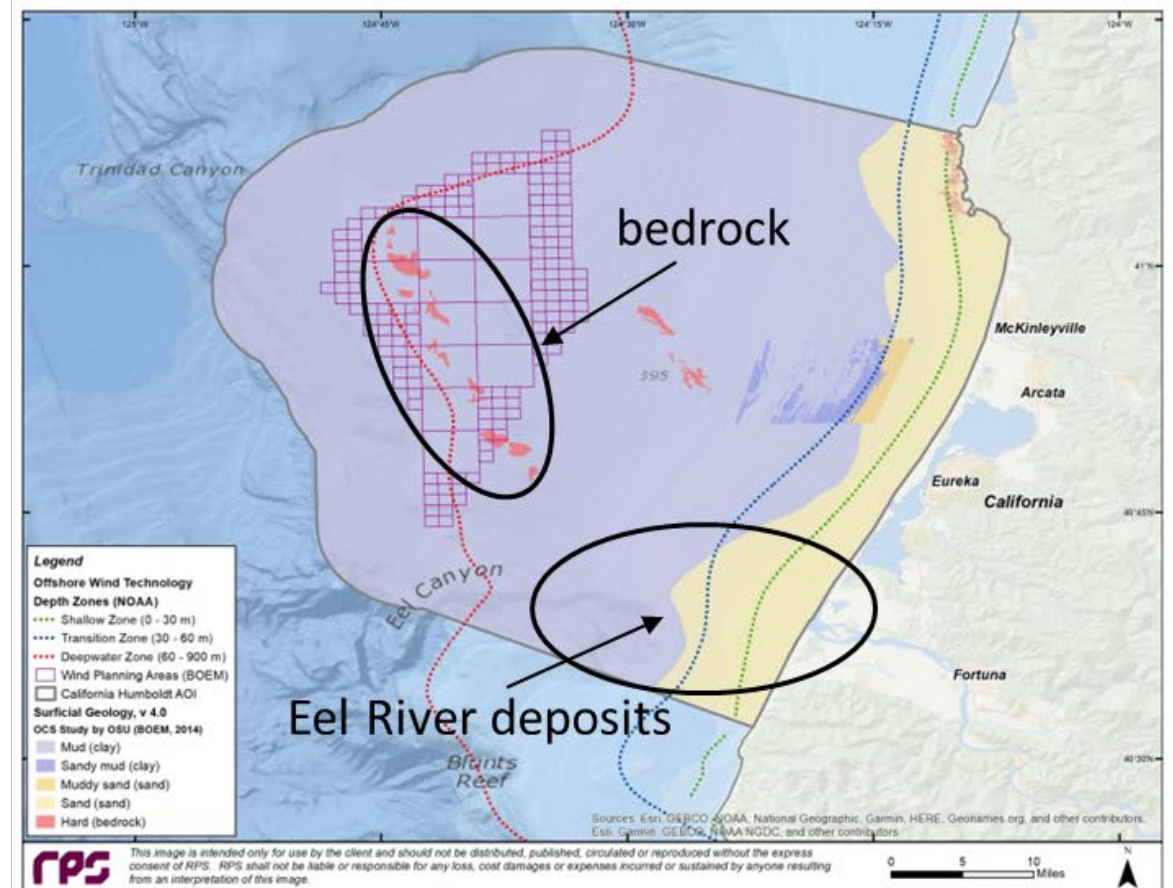
Morro Bay, Diablo Canyon Call Areas:

- bedrock, unconsolidated sediments

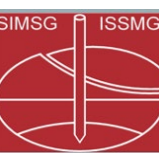


Humboldt Call Area:

- bedrock, unconsolidated sediments



University of
Massachusetts
Amherst



New challenges facing offshore wind

Deep water geohazards: landslide evidence



Many issues to consider
for floating wind anchor
selection and design

