Geophysical 4D modelling for geological site investigations

John Sawyer – Shailesh Patel - dr. ir. Peteralv Brabers

ArcDMC Sediment Solutions, LLC

Melbourne, Florida

(321) 728-8688

www.arcdmcsediment.com

Geological risks

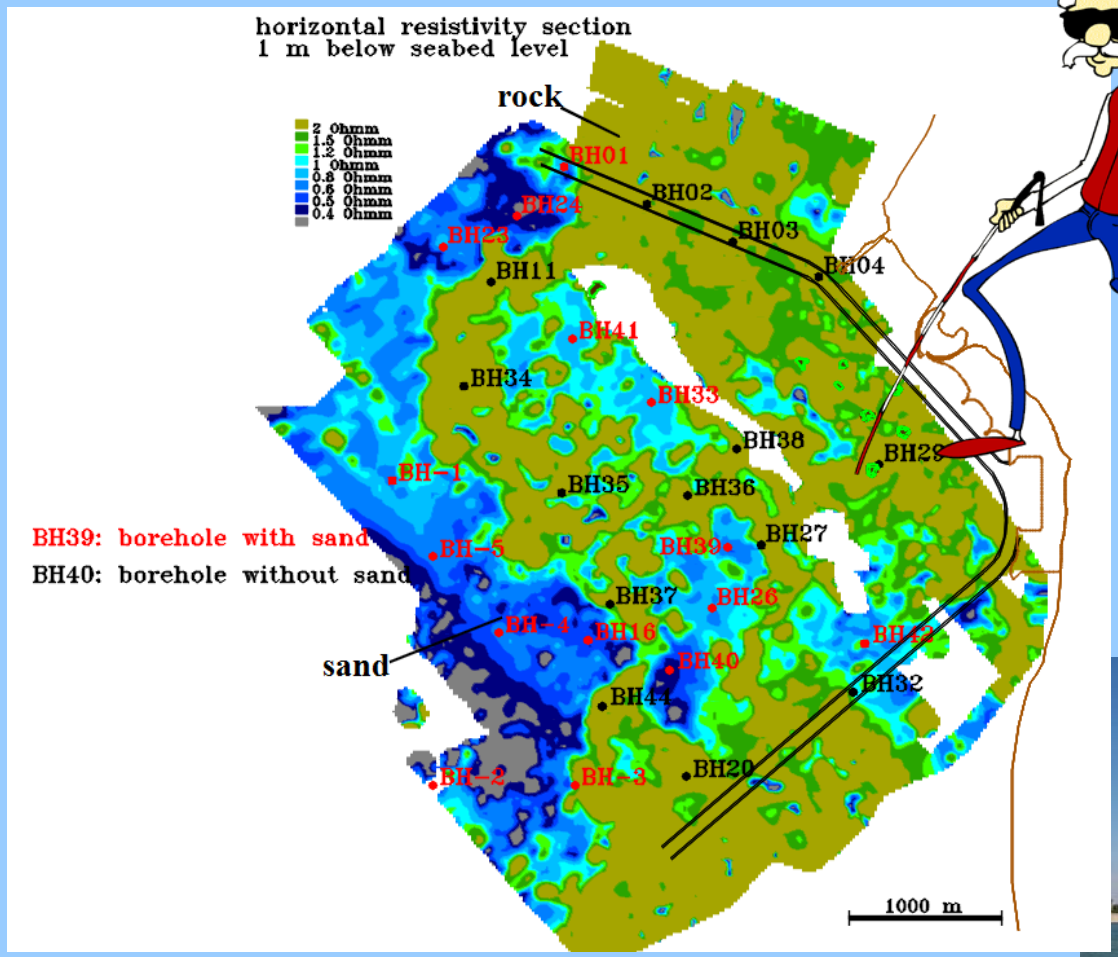
Why do we want to reduce geological risks?

→ to optimize project design adapted to the geological situation
→ to estimate realistic project budgets
→ to select appropriate working methods adapted to the geological situation
→ to optimize dredging rates
→ to avoid claim situations

How do we reduce geological risks?

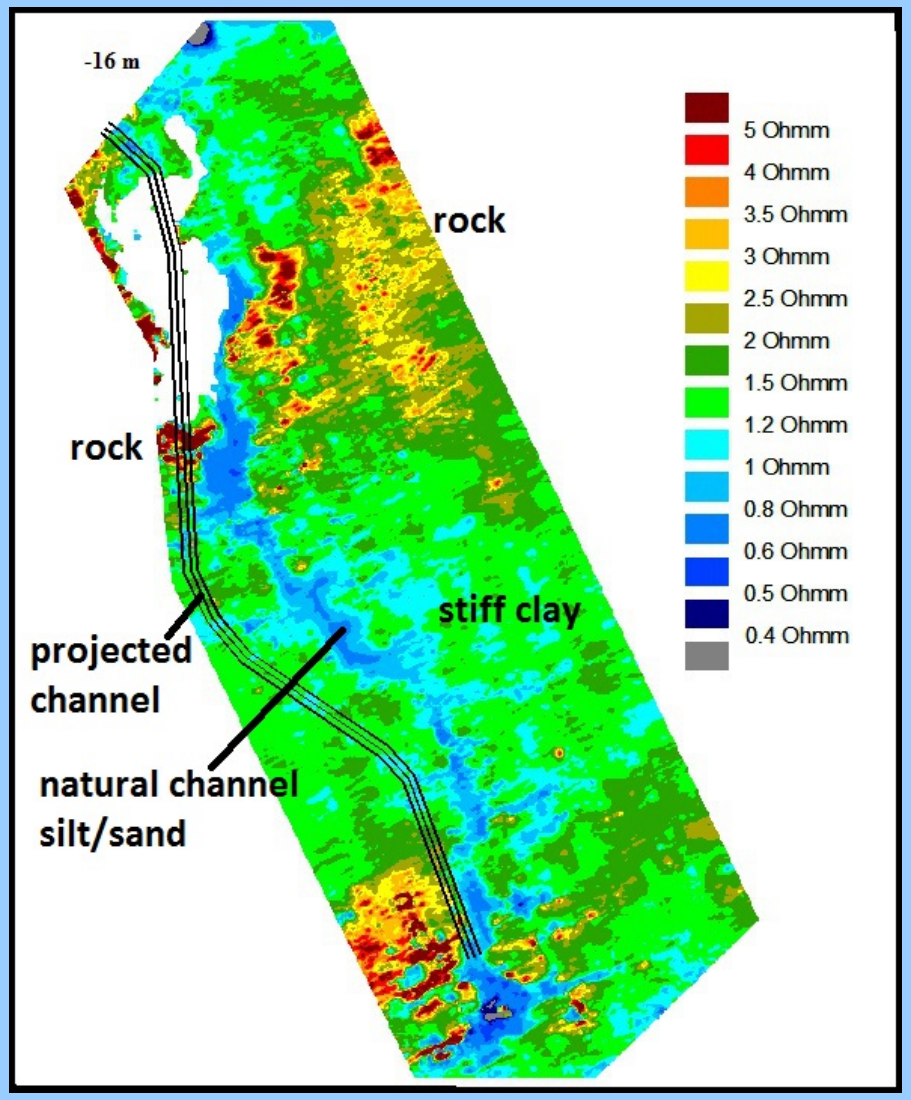
→ Site investigations using appropriate investigation methods accurately identifying extent and nature of geological structures in a detailed georeferenced ground model.

What is wrong with borings?



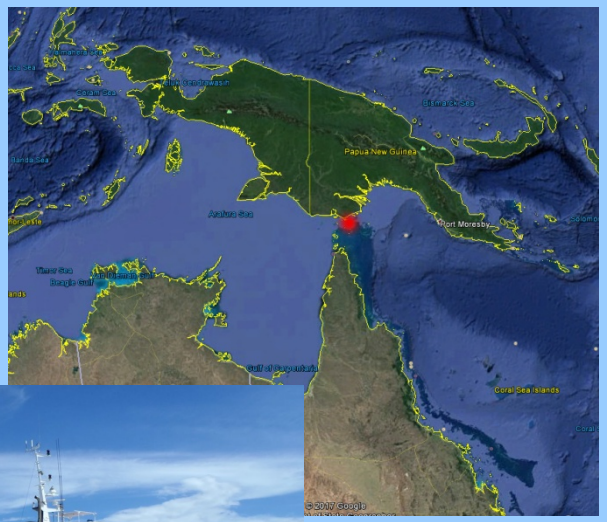
Boreholes alone can not define the extent of geological structures!

What happens if major geological structures remain unknown?



Previous investigations:

- seismic reflection
- 77 vibrocores and 116 random boreholes
- 12 million dollar exploration costs
- no sand
- undefined dredging risks
- uncertainty regarding project viability

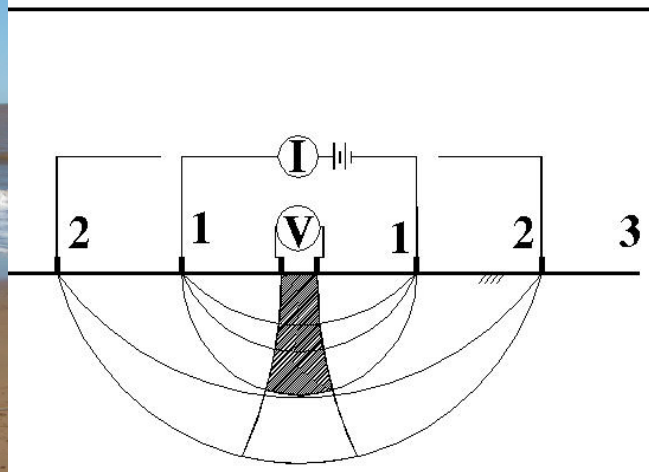


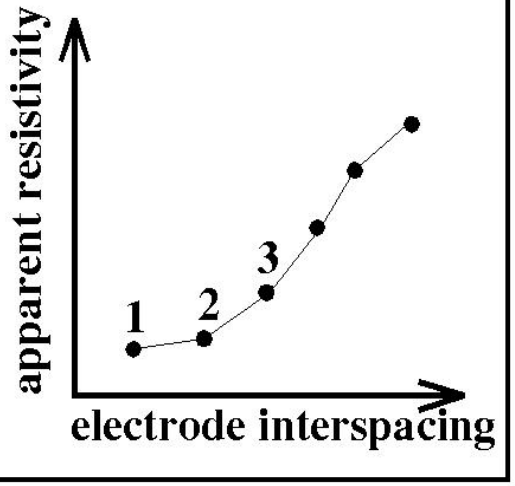
Site investigations

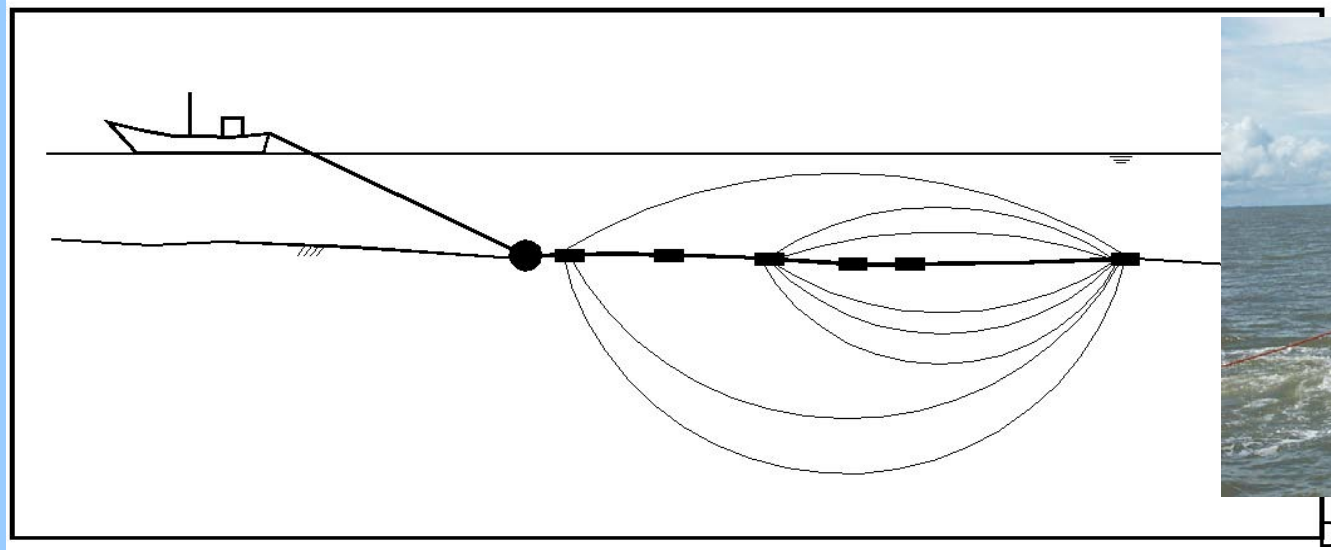
- Define horizontal and vertical extent of geological structures
  → using geophysical methods (fast and economical)
- Define the nature of the geological structures using boreholes (time consuming and costly) or other sampling methods. Select borehole locations based on geophysical information. Random boreholes are not effective. Laboratory testing on borehole samples provides geotechnical information of the geological structures.
- Combining geophysical and borehole results in a robust ground truthed 4D model. This 4D model (X,Y,Z,value) contains the base information for:
  - design
  - selection of working methods
  - environmental control
  - cost estimates

Aquares
Principles of electrical sounding

Demco NV







Aquares marine resistivity

Features:

Seabed towed cables -> high quality

Accuracy: no acoustic velocity information required

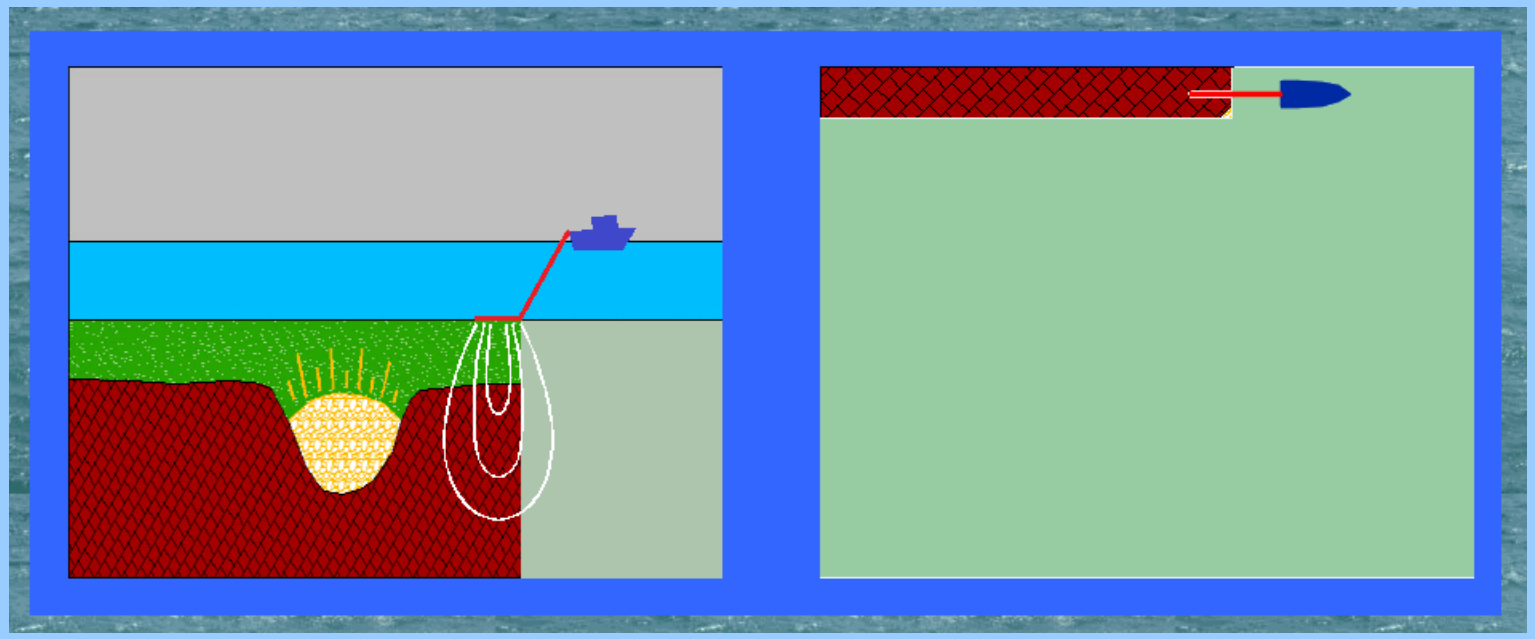
Quantitative: depths and thicknesses

Qualitative: resistivity value distinguishes between different rock and sediment qualities

4D model: every point in space has a resistivity value attached to it

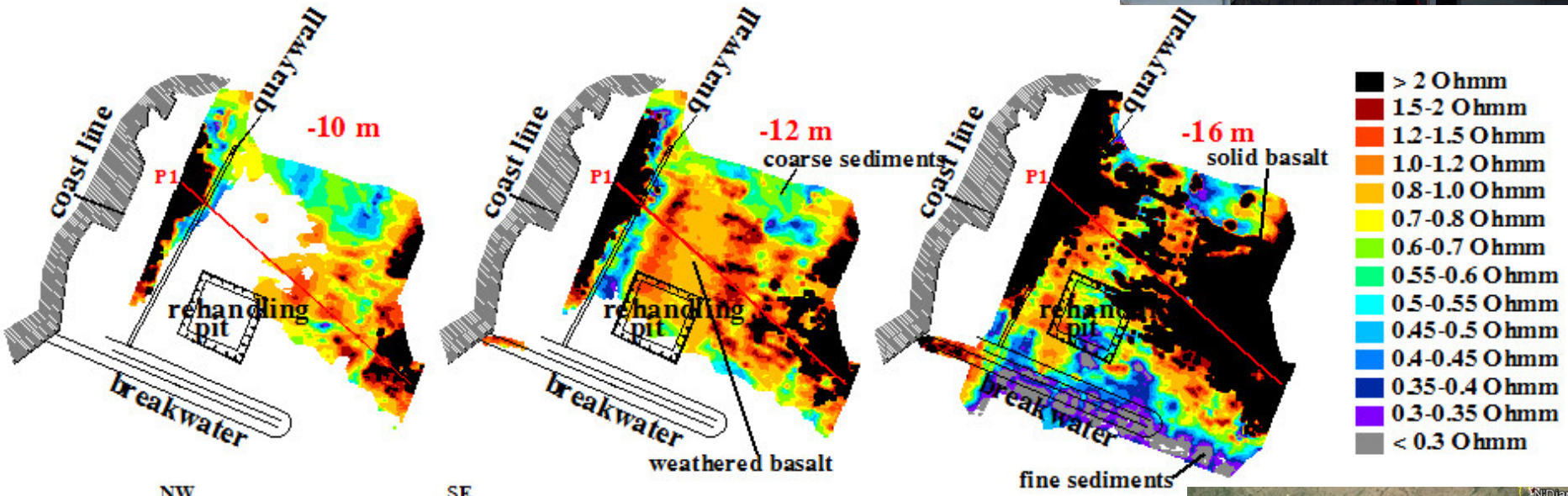
Applications:

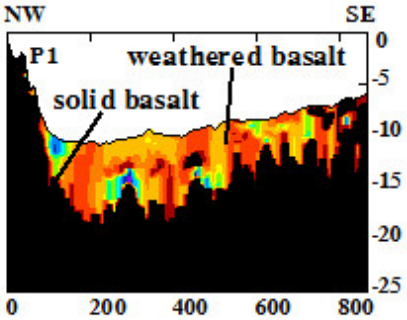
- Alluvial mining exploration (gravel / sand / gold / diamonds)
- Pipe / cable route surveys
- Dredging projects
- Port design



4D resistivity modelling

Port of Limbe, Cameroon





Port Canaveral resistivity survey

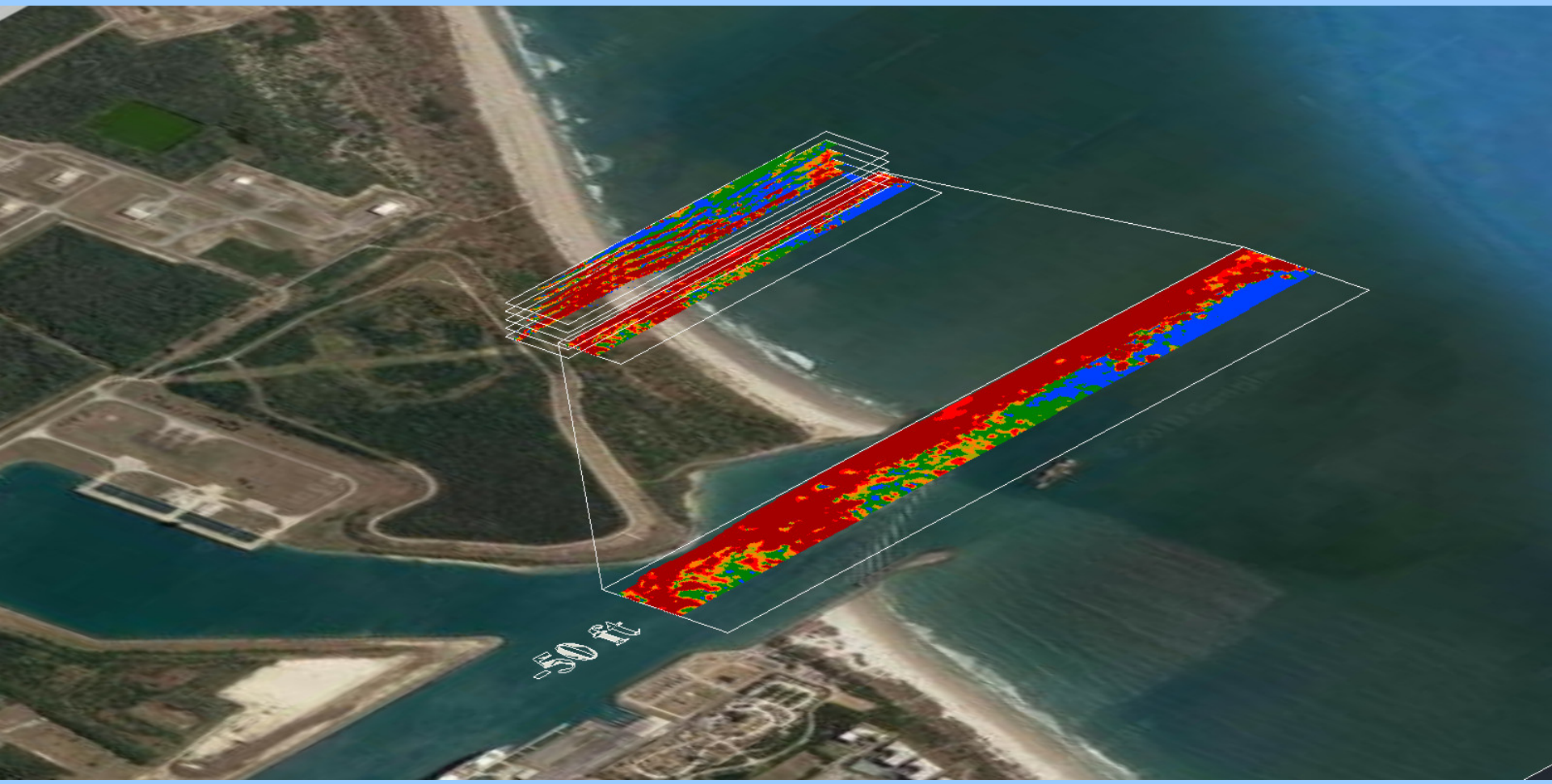
Bathymetry

Port Canaveral

Vertical resistivity sections

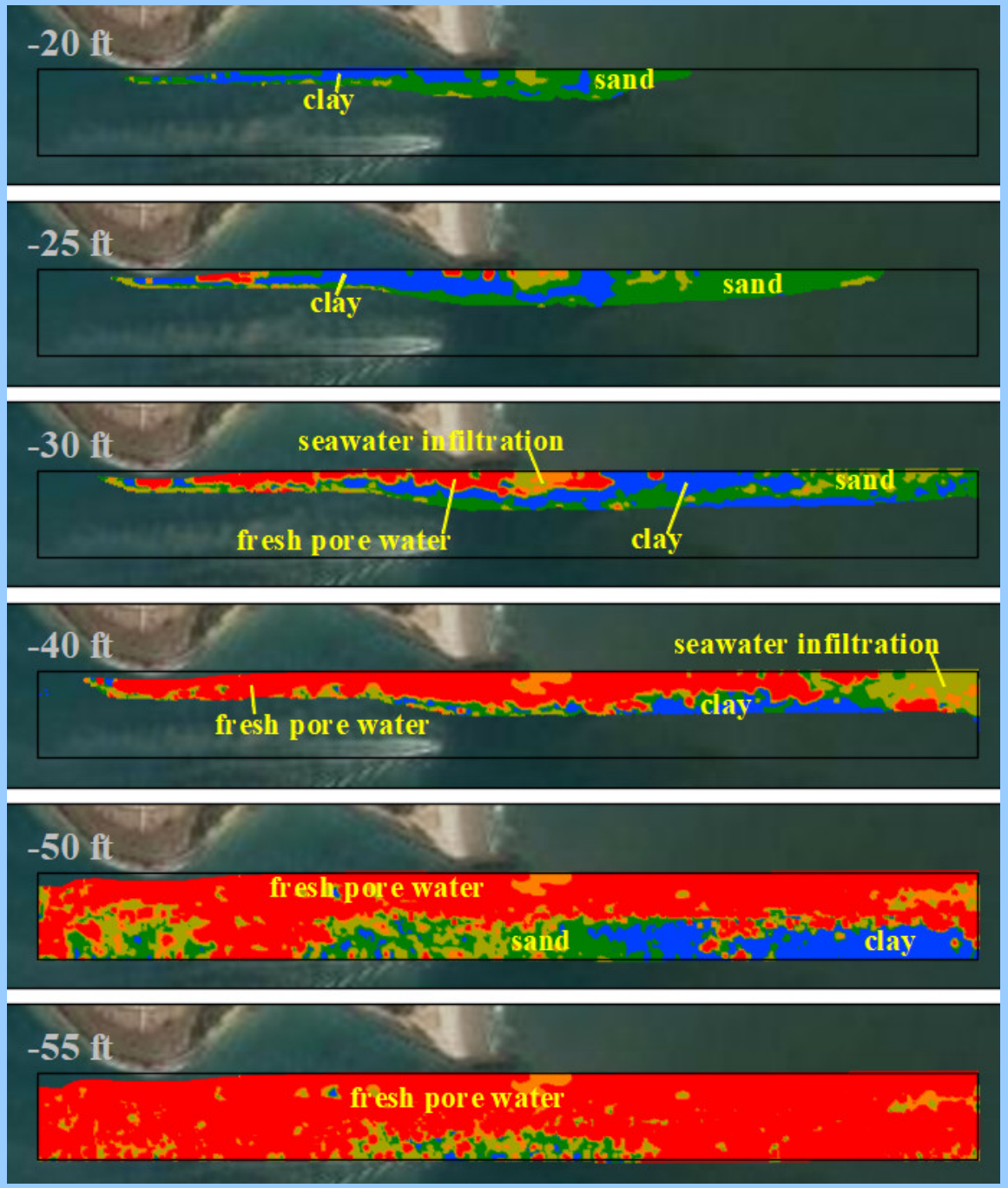
Port Canaveral

Horizontal resistivity sections



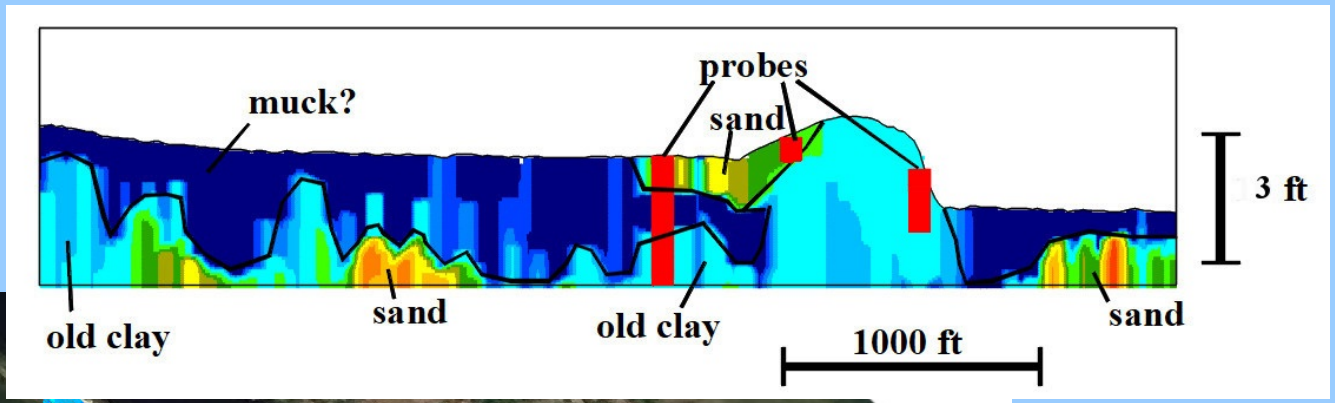
Port Canaveral

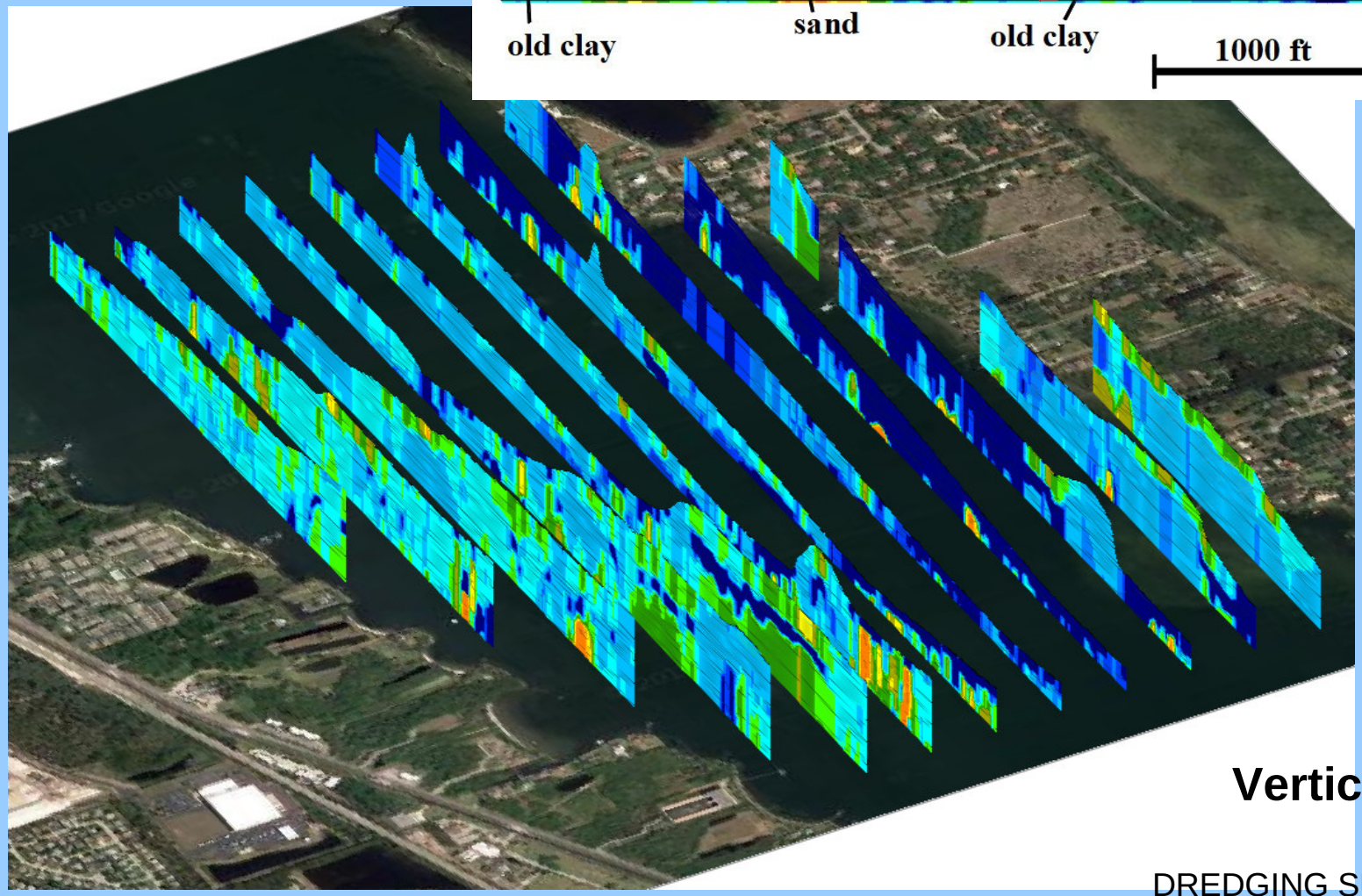
Horizontal resistivity sections relative to chart datum



Indian River muck survey

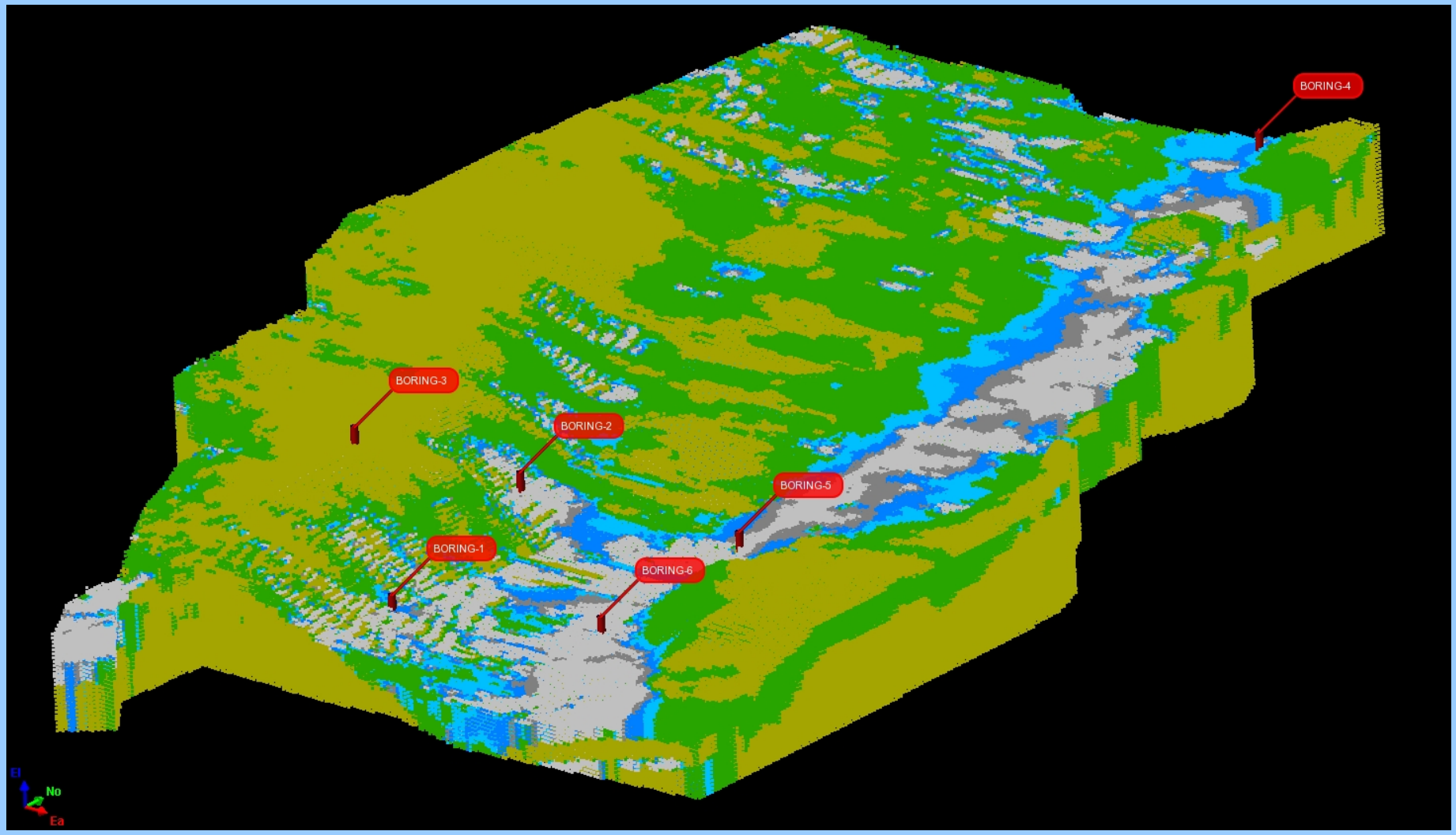
Tentative Interpretation





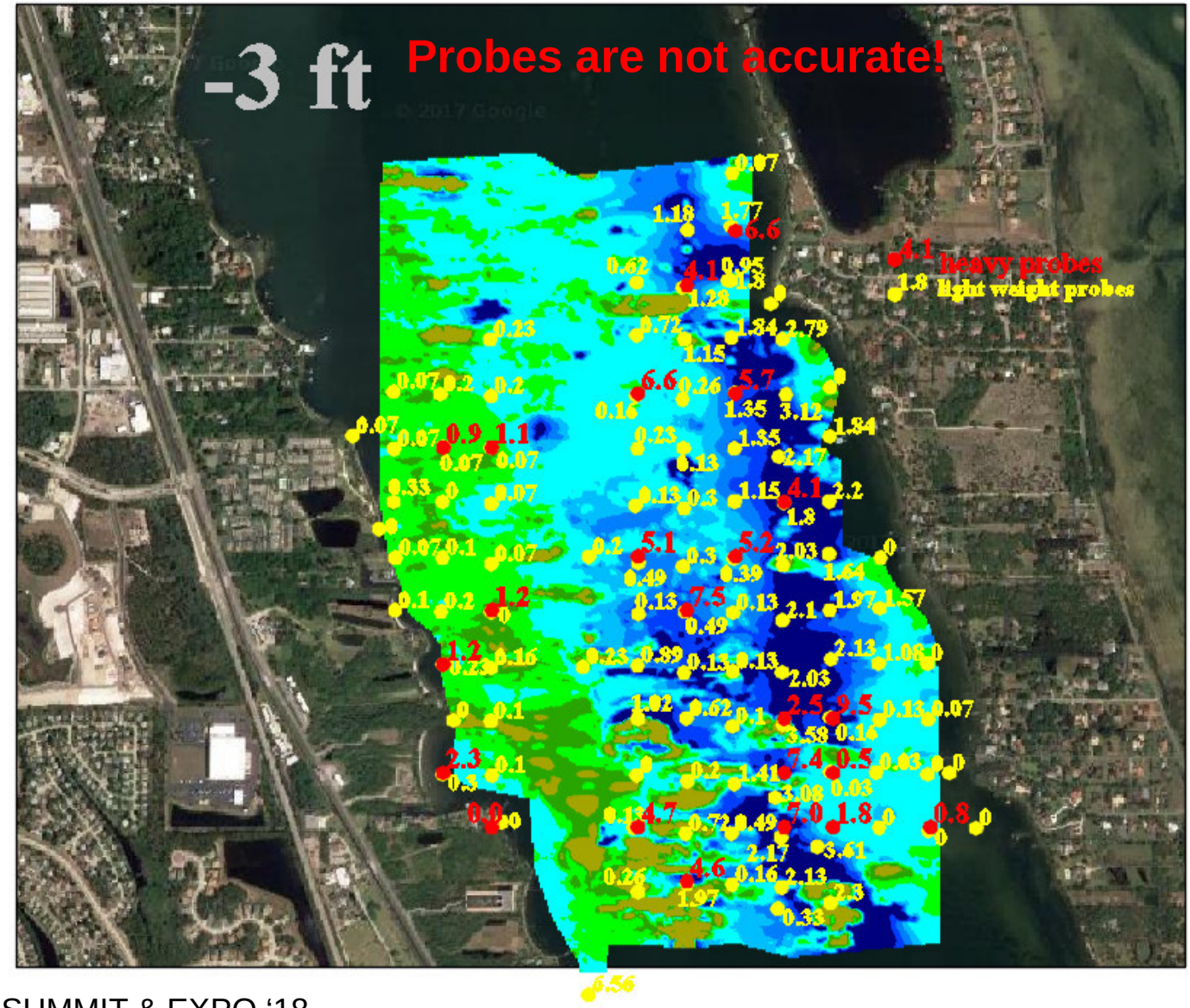
Vertical sections

4D Resistivity Model



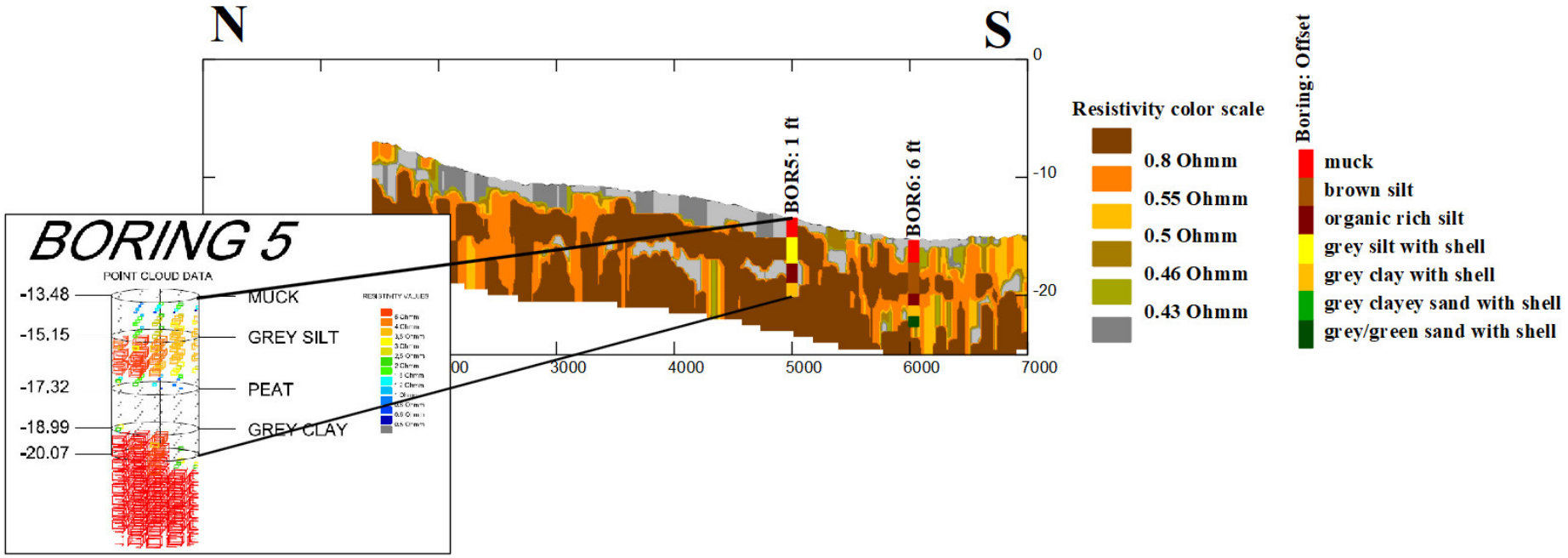
Indian River muck resistivity survey

Probe penetrations in feet



Indian River muck resistivity survey

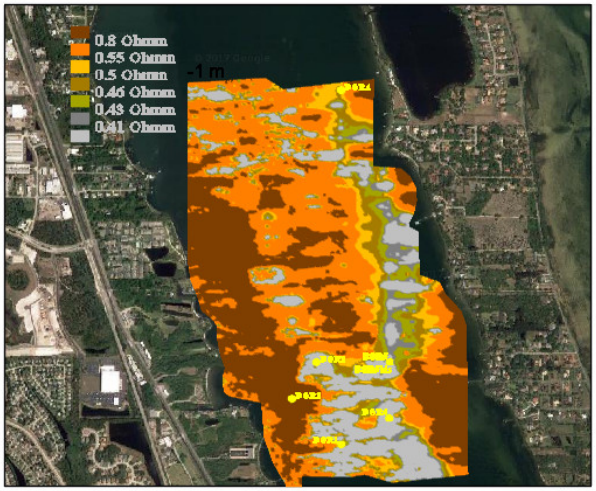
Vibrocore correlations



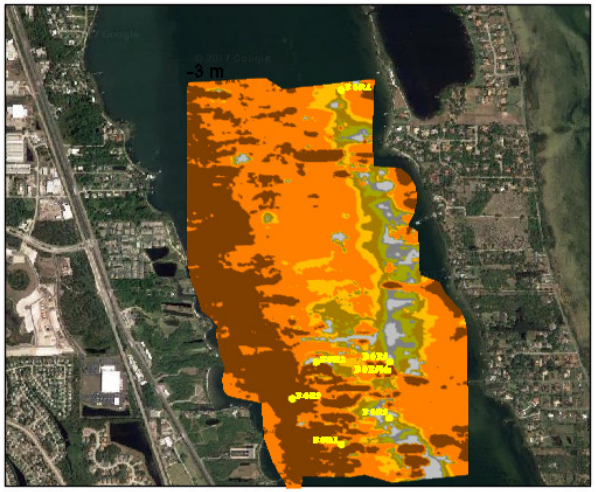
Indian River muck resistivity survey

Muck volumes

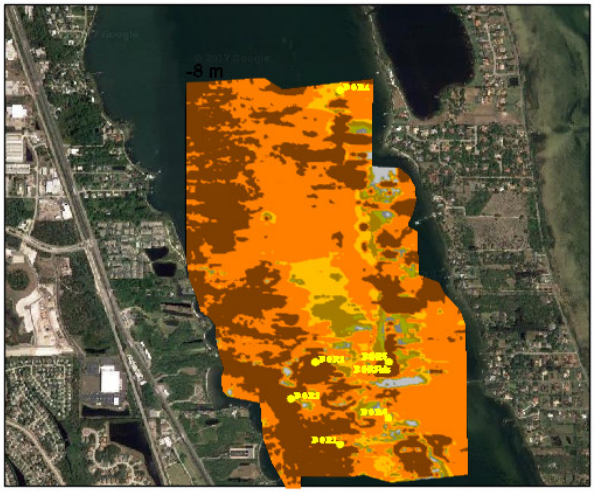
-1 ft



-3 ft



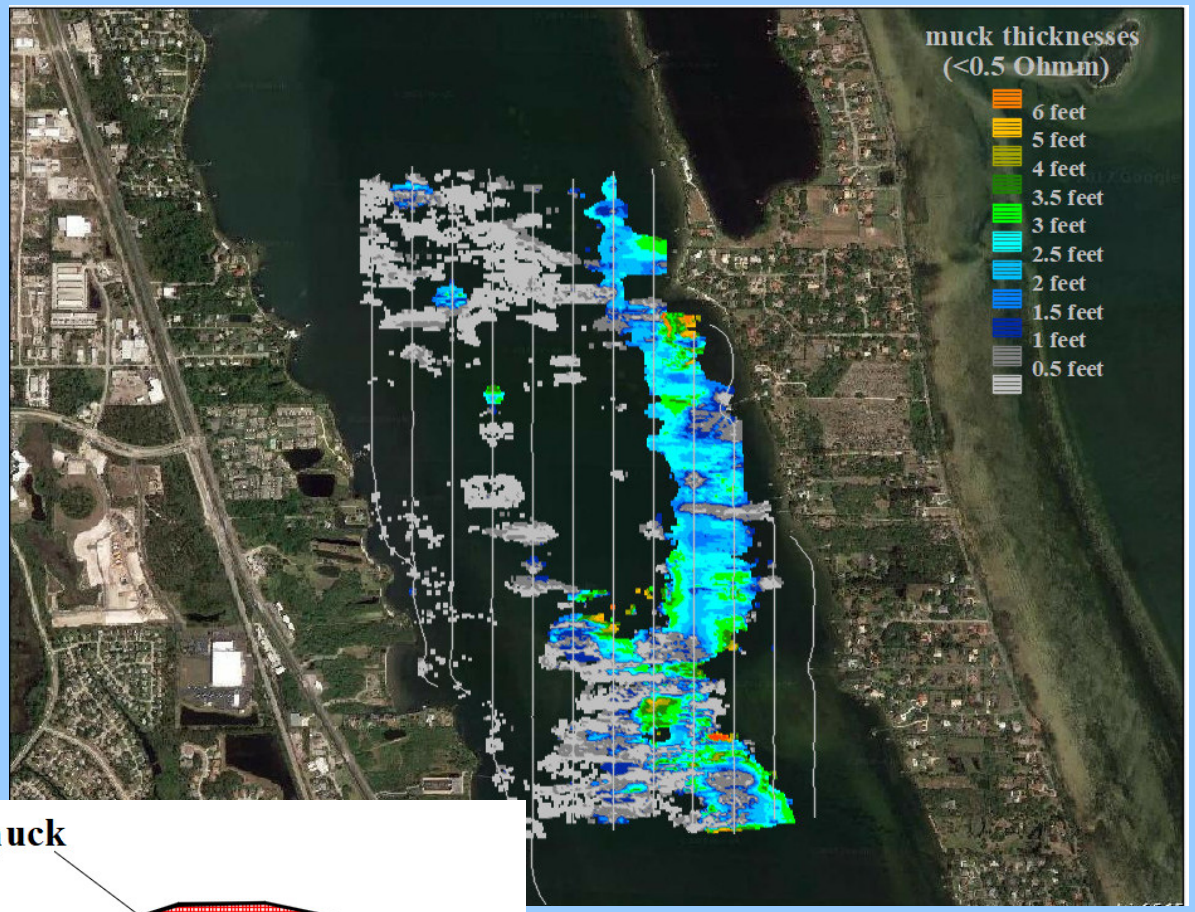
-8 ft

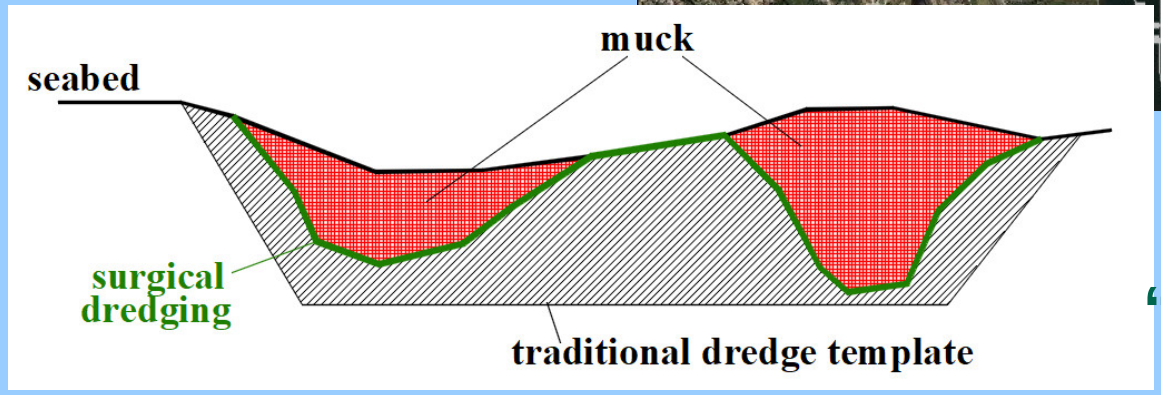


Grey, green: muck with shell
Orange: clay with shell
Brown: stiff clay, sand with shell

Indian River muck resistivity survey

Muck thicknesses





“Surgical” dredging