Secular evolution of sandy coasts of Normandy (NW France)

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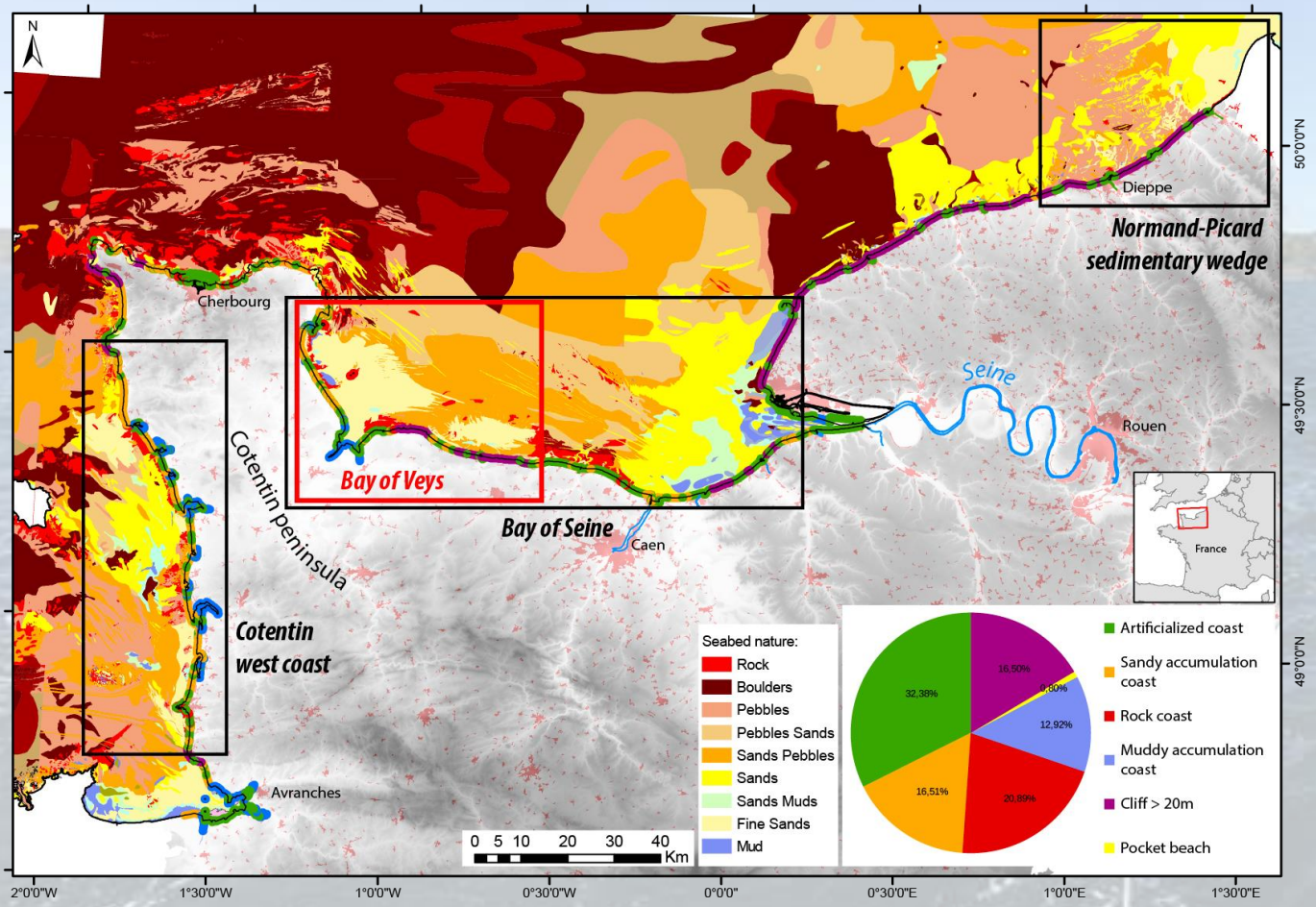
EGU2020
Sharing Geoscience Online

Problematic & context

This study focus on recent and mobile ‘offshore’ sediments, potentially available for shoreface and foreshore supply.

- Relationships subtidal sediment - shoreline evolutions → Joint dynamics
- Observations at a regional scale → Trends
- Evolution since Little Ice Age

An innovative approach



G maps compilation (scales : 1/150 000 et 1/50 000), Shom.

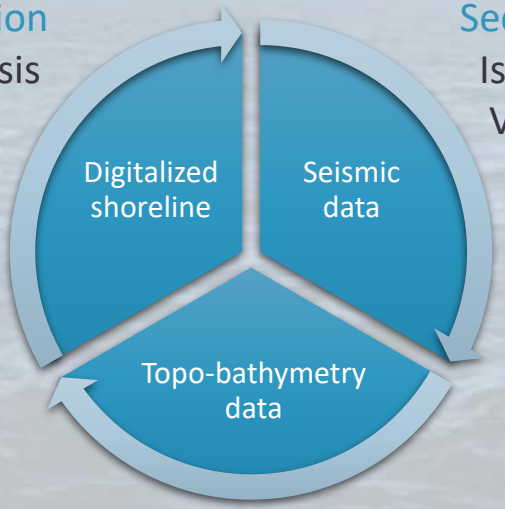
Study area: Normandy coasts with 3 main targets (black areas) selected on the basis of shoreline type and seabed nature. The presentation focus on the **Bay of Veys** (red area) including the D-Day landing beaches of Utah and Omaha.

Shoreline evolution

Diachronic analysis

Mobility analysis

- Morphology
- Position



Sedimentary stocks

Isopach map

Volume calculation

Internal geometry

Sediment dynamics

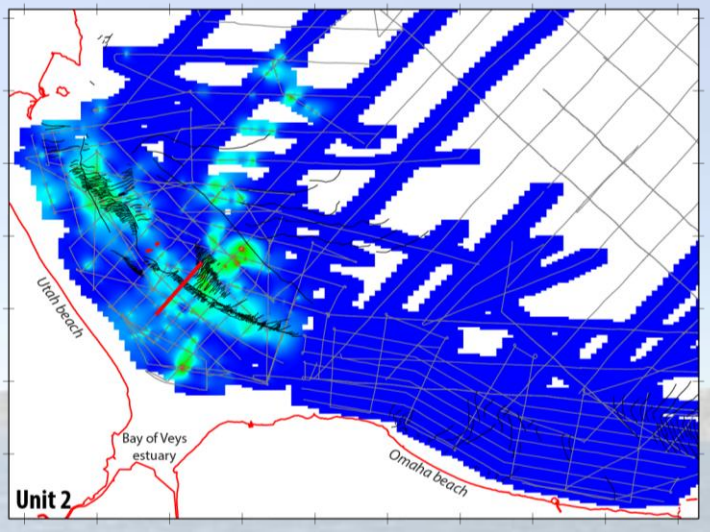
Identification of hydro-sedimentary bedforms

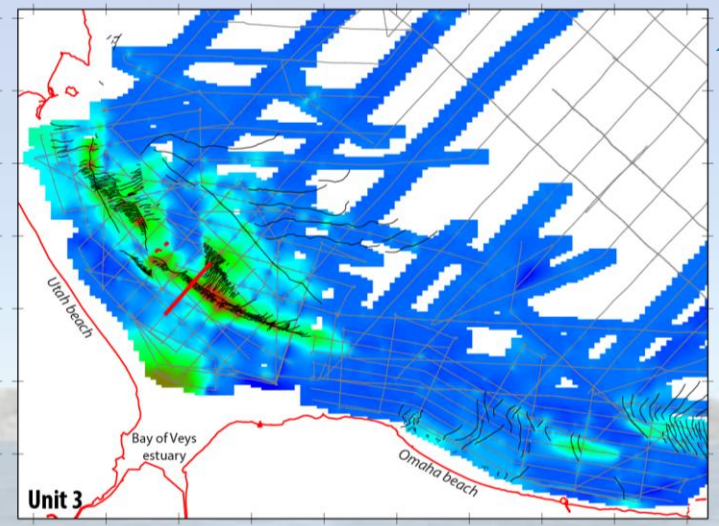
Sediment mobility: directions, distances, volumes

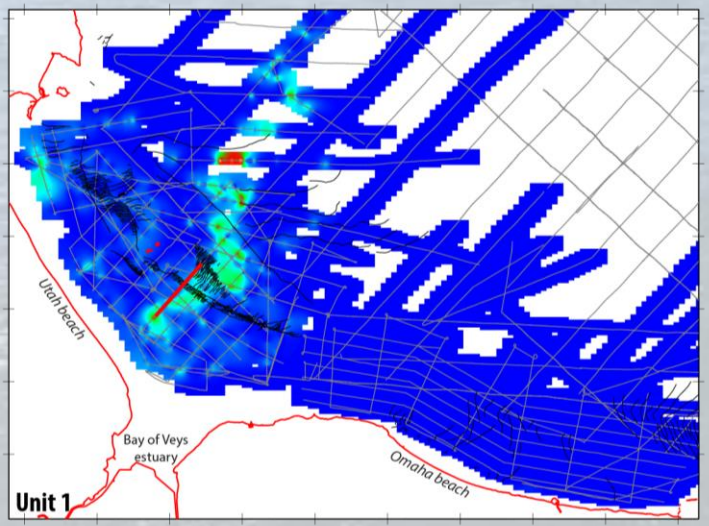
Sedimentary stocks

Defined by USU '*upper sand units*', limited at their base by hard floor (bedrock) and accumulated under high sea level conditions (Certain *et al.*, 2005).

In the Bay of Veys, according to seismic data, the sediment cover over the bedrock comprises 3 units related to the sediment infill of incised valleys and coastal wedge construction during the Holocene transgression (Tessier *et al.*, 2010 ; Tessier *et al.*, 2012).







Unit 3: HST: subtidal banks and dunes + costal wedge construction

- ***Maximum Flooding Surface (3000/2000 cal yr BP)***

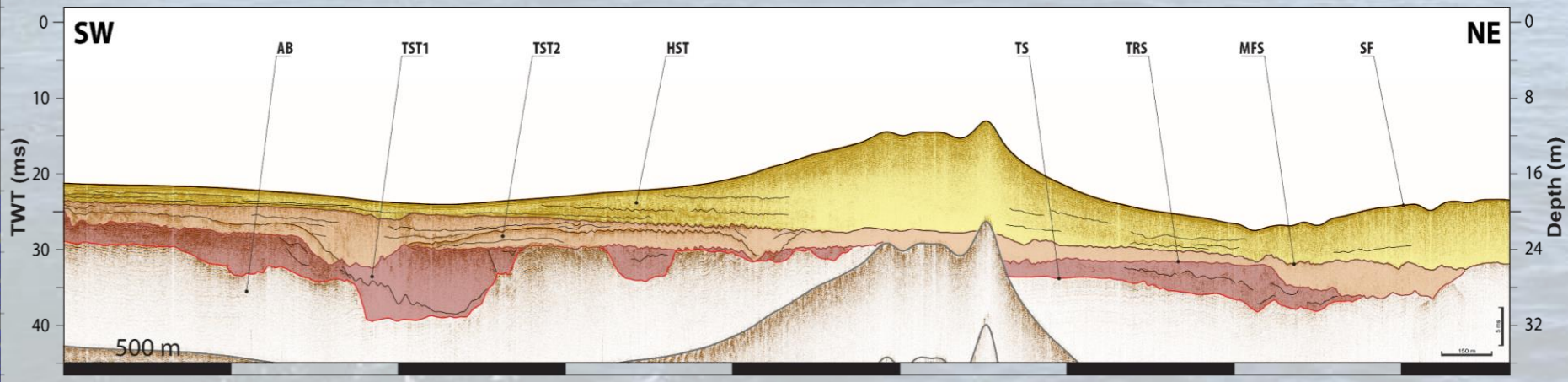
Unit 2: TST 2: estuary infilling + bank initiation

- ***Tidal Ravinement surface : (6000 cal yr BP)***

Unit 1: TST1: paleo-valley infilling

- ***Top of the bedrock (lower Jurassic)***

Isopach maps – interpolation 'gradient projection' with Kingdom Suite



Substratum
Accoustic basement (AB)

Sedimentary units
Unit 3: Highstand System Tract (HST)
Unit 2: Transgressive System Tract 2 (TST2)
Unit 1: Transgressive System Tract 1 (TST1)

Unconformity surfaces
Top of Substratum (TS)
Maximum Flooding Surface (MFS)
Tidal Ravinement Surface (TRS)
Seafloor (SF)

Seismic data: boomer profil 'boomBdV3'

Sediment dynamics

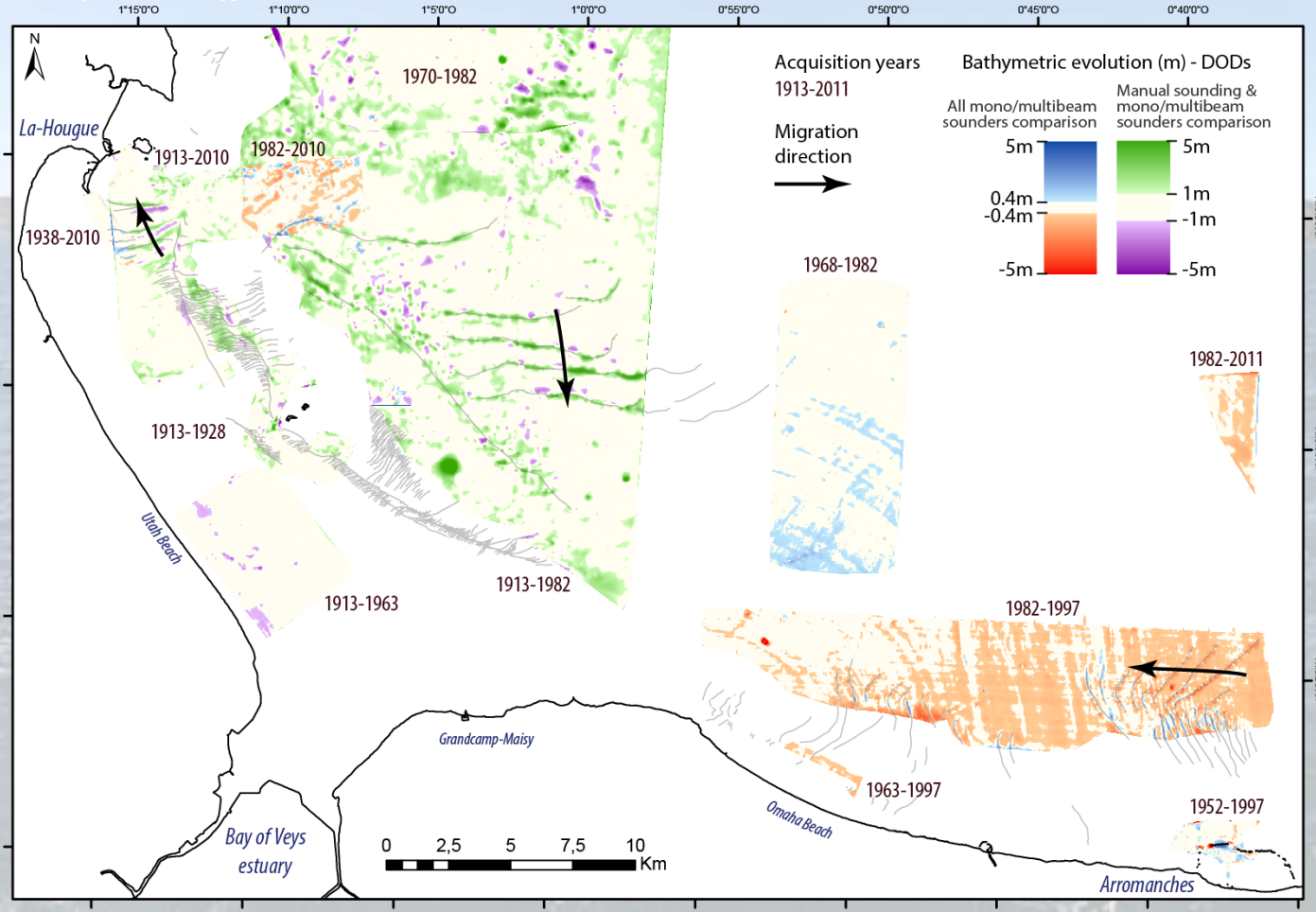
Analysis of historical evolution of sediment volumes and bedforms migration: regional pattern of sediment dynamics over the last centuries.

20m grid DODs created from punctual bathymetric data from Nautical Charts (Shom). Acquisition: from 1913 to 2011.

Limitations: limited spatial and time overlay

→ analysis restricted to some areas.

Bathymetric differential (DODs)– DEM cells 20m



Margin of error in vertical precision depends on acquisition type:

- Manual depth sounding ≈ 1m
- Mono/multibeam acoustic sounders ≈ 0,3m

Calculation of the most probable margin of error (Brasington *et al.*, 2003): $\delta U = \sqrt{\delta Z_{t1}{}^2 + \delta Z_{t2}{}^2}$

Three main observations types:

- Erosion trend
  - Exposed coastal linear
  - Around wrecks and islands
- Accretion trend
  - Sand dune formation
  - Central sand bank
  - Around wrecks
- Sand dunes migration velocity
  - *La Hougue*: ≈ 2 to 2,5 m/yr (northward)
  - *Center of the bay*: ≈ 2 to 3 m/yr (southward)
  - *Arromanches*: ≈ 5 to 5,5 m/yr (westward)

  → Conform to residual tidal currents

Shoreline evolution

Shoreline observations

Recent shoreline: 1947 to actual

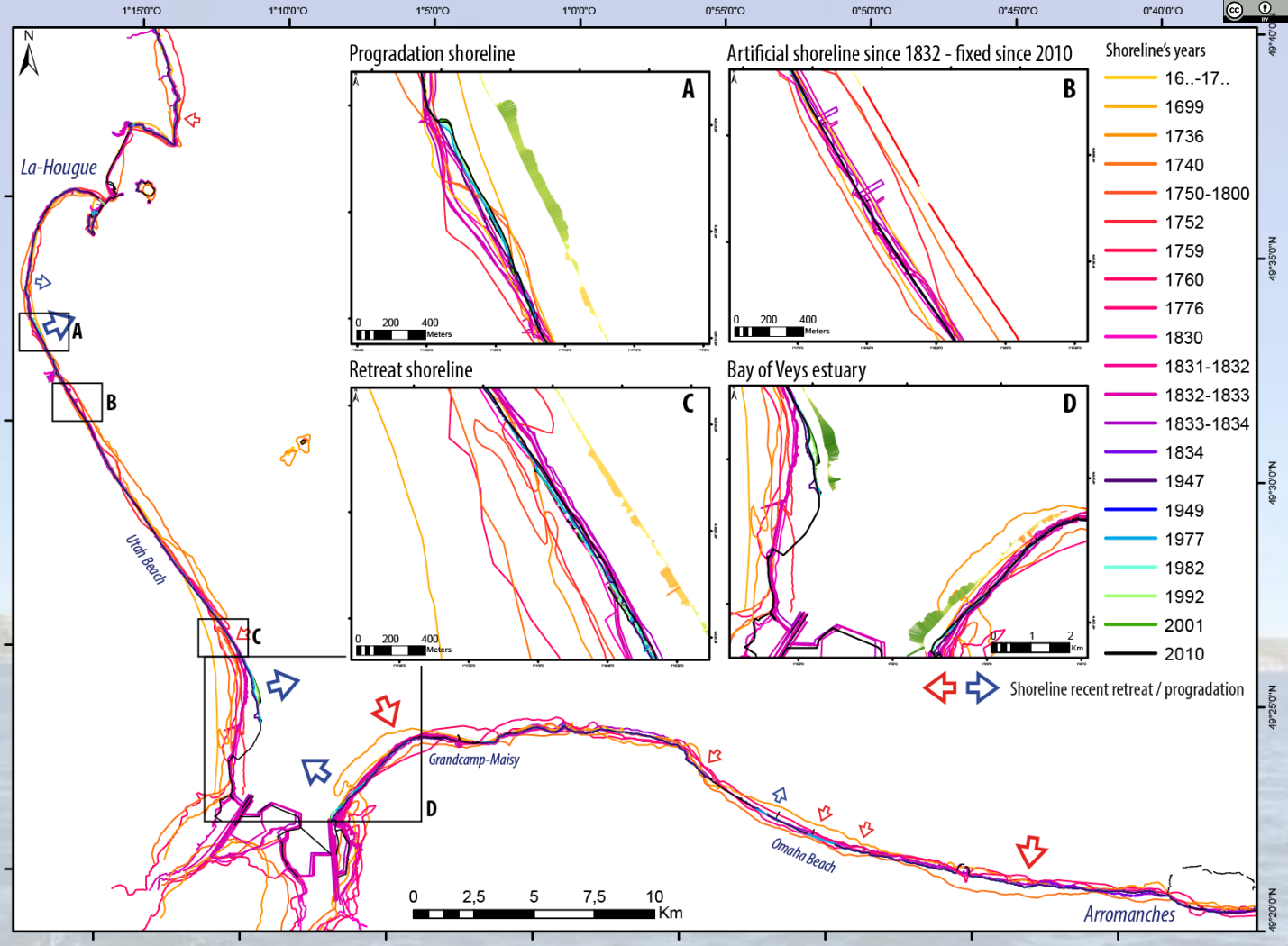
- By *ROL* & *Cerema* & *DREAL*
- From orthophotographies
- Reliable trends since 1947

Historic shoreline: from XVII century to 1949

- Shoreline positions digitized from cartographic records (Cassini, '*Etat Major*', Nautical Chart, various maps…)

Margins of error: multi-parameter

- Georeferencing: variable
- Historic mapping error ≈ 100 to 200m
- Choice of coastline indicator/marker
- Shoreline digitization ≈ 10 to 20m



Digitalized shoreline available in targeted areas, with histograms (green: progradation, red: retreat) produced by the ROL from orthophotography's shorelines (1947 to 2010)

Qualitative observations

- Confirm/refute recent trend

Sustainable progradation (A) & (D)
Old artificialisation: link to retreat? (B)
Historic progradation and recent retreat (C)

- Evolution of coastal features

Sandspits punctual existence 1750 to 1800 (C)
Estuary anthropogenic modification and natural infilling (D)

Quantitative approach

Impossible, due to important and indefinable (multi-parameter) margin of error

Conclusion & perspectives

This work allows

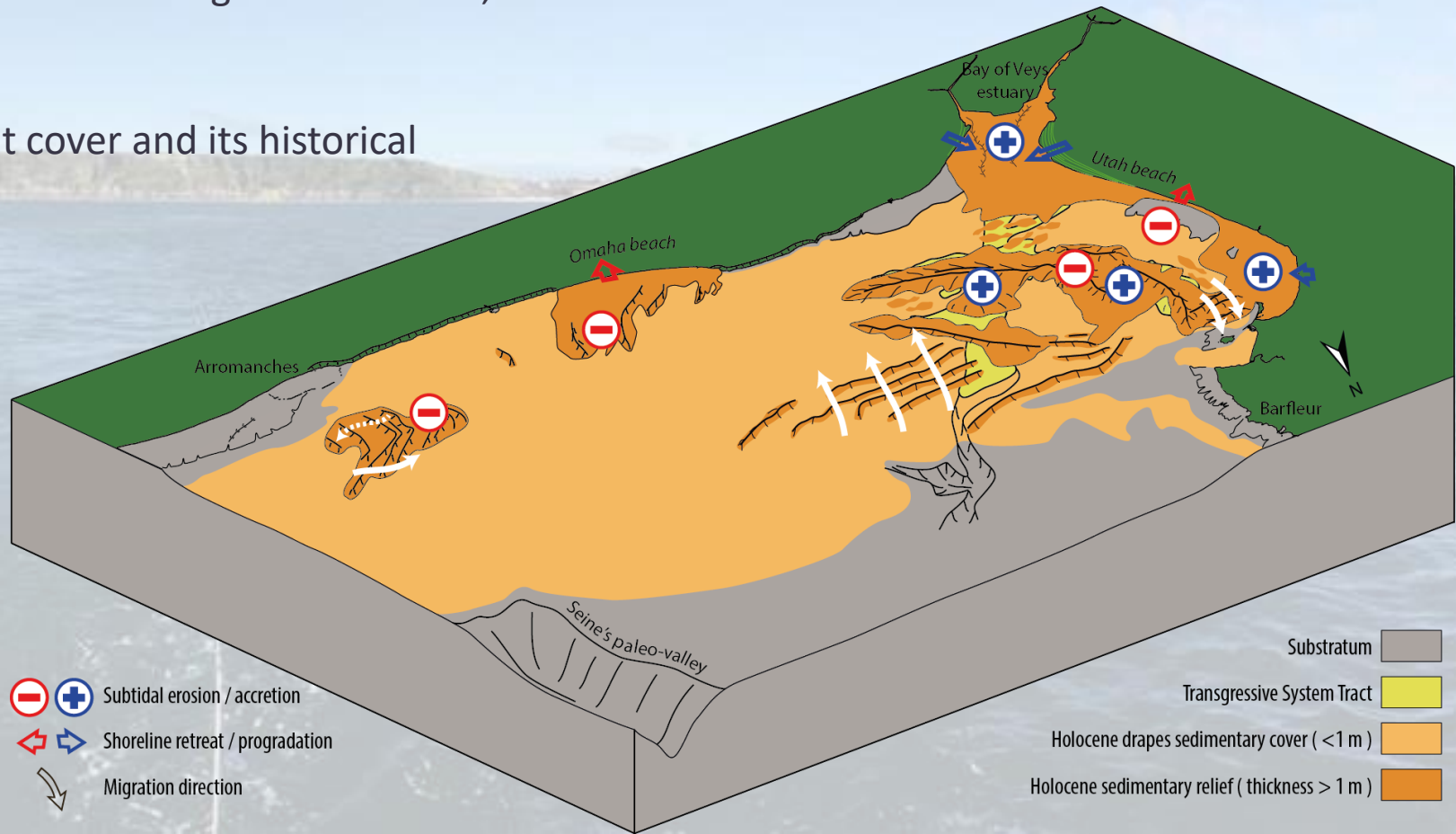
- Reconstructing the long term (Holocene) sedimentary evolution of the Bay of Veys: with 3 main steps early and late transgression (estuarine infillings), high stand sea level context (final coastal wedge construction, subtidal sediment cover and bank build-up
- Quantifying the volume of subtidal sediment cover and its historical mobility, as well as the shoreline position

Next steps

- Extension of the study at the scale of the whole Normandy coastal domain (with acquisition of new seismic data)
- Quantification of the thicknesses and volumes of mobile sediment
- Calculation of sedimentary fluxes

Good coherence of evolution between subtidal domain and adjacent shorelines

- Protected coastline: sediment gain
- Exposed coastline: sediment loss



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