An overview of the use of acoustic data for geology and habitat mapping in MAREANO

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Core information for geology and habitat mapping

acoustic data
  - bathymetry
  - backscatter

seabed geomorphology

seabed processes

seabed sediments

near-surface geology

shallow seismic

water column data
Basis for geological and habitat map development

Bathymetry and backscatter maps

Terrain variables for habitat mapping +

Landscape (broad-scale geomorphic features)

Landforms (local seabed geomorphic features)

Sediment grain size

Sedimentary environment

Sediment genesis (formation)

+ ESSENTIAL BASIS FOR BIO/GEO CRUISE PLANNING
Bathymetry data processing and analysis

Gridded data (NHS) → Raster bathymetry and hillshade (ArcGIS)

Quantitative terrain analysis (GIS)

Landscape map

Terrain variables for habitat mapping

Sediment interpretation

Summary of the types of terrain variables that can be derived from bathymetry data. From Dolan et al. 2012 NGU report 2012.045 (Geo-Seas)
**Geomorphic and ecological relevance of different types of terrain parameters**

From Dolan et al. 2012. NGU report 2012.045 (Geo-Seas)

<table>
<thead>
<tr>
<th>Slope</th>
<th>Orientation</th>
<th>Curvature and Relative Position</th>
<th>Terrain Variability</th>
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</thead>
<tbody>
<tr>
<td><strong>Ecological relevance</strong></td>
<td>Stability of sediments (ability to live in/on sediments)</td>
<td>Exposure to dominant and/or local currents from a particular direction (food supply, larval dispersion etc.)</td>
<td>Index of degree of habitat structure, shelter from exposure/predators (link to life stages). Structural diversity linked to biodiversity</td>
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<td>Local acceleration of currents (food supply, exposure, etc.)</td>
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<td>Terrain variability and structures present reflect dominant geomorphic processes.</td>
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</tbody>
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Terrain variables - scale, resolution and computation methods matter

Example of single-scale (3x3 analysis window) slope at three different cell sizes (a) 5 m, (b) 50 m, (c) 500 m. The same colour scale is used for slope values across each cell size. From Dolan 2012. NGU Report 2012.041
Landscape maps

Use terrain variables from multibeam bathymetry to help delineate landscape features.

Analysis based on 50 m grid multibeam data.

Identify key terrain variables to keep classification as simple as possible –

Identify suitable ’cut-off’ values for variables to delineate landscape features.
Landscape and landform maps

- Pockmarks
- Glacial lineations
- Sandwaves

Ottesen et al. 2008
Backscatter data processing and analysis

Raw data → FMGT → Raster mosaic (ArcGIS)

GSC, (Poseidon)

MAREANO tested ARA in FMGT, limited use in geo-workflow to date.

Tested QTC – limited use with large data volumes.

Part of figure from Brown C.J., et al. (2011) ECSS 92
Backscatter data – unlevelled, ’patchwork’

Acoustic reflectivity – indicates the nature of the seabed (grain size/roughness/compactness)

- Different years
- Different boats
- Different multibeam systems
- Different contractors
- Different depths - resolution

Data require harmonisation…
Backscatter data after arithmetic levelling

Levelling requires overlap region (restricts application)

Varied success

Does not account for different frequency multibeam data used

Calibration methods for new data? Old data must be used
Unsupervised classification for bio/geo cruise planning (video & sampling)

ISOCLUSTER/MLC classification using simple combination of fine/broad scale terrain variables + backscatter

Physically different areas shown in contrasting colours

Help objective cruise planning
Acoustic data for sediment interpretation – integrating datasets, assimilating knowledge

TOPAS reveals thin, fine grained surface layer underlain by glacial sediments. All draping over deeper bedrock. Not moraine ridge.


Often backscatter gives clear indication of sediment which matches video observations. e.g. moraine ridge

Sometimes backscatter here shows less variation but TOPAS reveals the geological history and gives further info on sediments
Sediment grain size
Sediment genesis (formation)

Glacial moraines - mixture of sediments of varying particle size, ranging from clay to large boulders.

Marine suspension deposits are fine-grained sediments.

Marine bottom current deposits - dominated by sand.

Avalanche/slide material - mixture of particle sizes with poor sorting.
Sedimentary environment (deposition/erosion areas)

Interpretation from sediment grain size/bedforms

Infer bottom currents
Multibeam water column data

Data from the project ‘Neotectonics and Fluid Flow Processes in the Southwestern Barents Sea’ in the Hola trough, NW Norway - an area mapped by MAREANO prior to water column data acquisition

Large data volumes but useful data
- gas flares
- fish/mammals
- more?

MAREANO - Integrating alternative bathymetry data

Simulation study for sediment biotope mapping using Olex & Multibeam data

Olex and multibeam data used from video/sampling cruise planning Autumn 2012
Lessons learned and potential for future use of acoustic data in MAREANO…

- seabed geomorphology
- seabed processes
- seabed sediments
- water column data
- acoustic data
  bathymetry
  backscatter
- shallow seismic
- near-surface geology
Lessons learned and potential for future use of acoustic data in MAREANO…

• Acoustic data also means managing a huge volume of data
• Challenge to harmonise data, especially backscatter
• Easy to under-use data + too easy to ignore limitations w.r.t. acoustics
• Scale, resolution, method important w.r.t. terrain variables
• Semi-automated interpretation of sediments? Automated feature detection? corals, pockmarks, glacial features
• Integration of TOPAS, ground truth + existing knowledge is vital for geo- interp
• Additional ground truth opportunities (eyeball camera etc.)
• Potential for integration with datasets at other resolution – high (UUV based MBES, SAS etc.) and low (Olex, regional bathy), other seismic