



Shallow Survey 2005 Plymouth  
Tue 13<sup>th</sup> September 9.00h session 1: Survey Systems

## 3D Chirp Sub-Bottom Imaging System: Design and 3D Volumes

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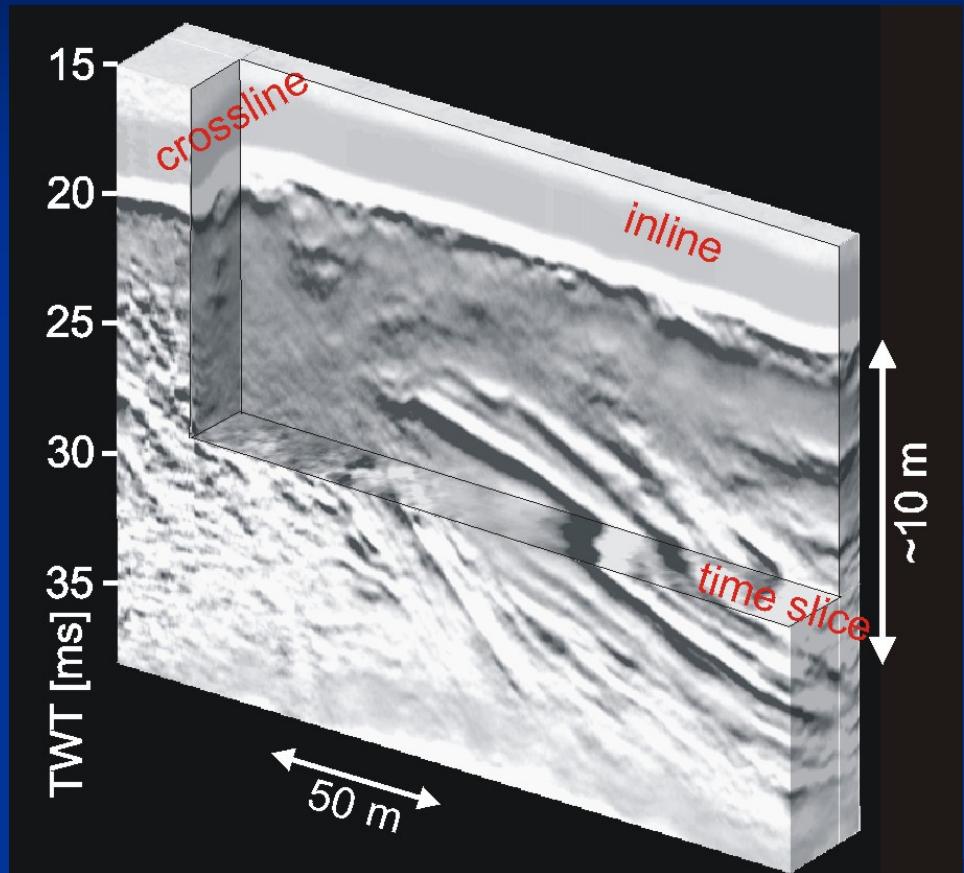
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# 3D Chirp



## 3D High Resolution Imaging

- Marine Engineering
- Defence
- Marine Geology
- Marine Archaeology
- ...



## 3D Seismic Imaging

- Produce a *3D data volume* rather than *2D sections*
  - Can be viewed in horizontal, vertical and arbitrary slices independent of acquisition directions
  - 3D processing: higher data quality and resolution
- Fully sample the reflected wavefield over an area
- Standard tool in hydrocarbon exploration
  - 10s of meter resolution kilometres penetration

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## Downscaling to 3D high resolution seismics

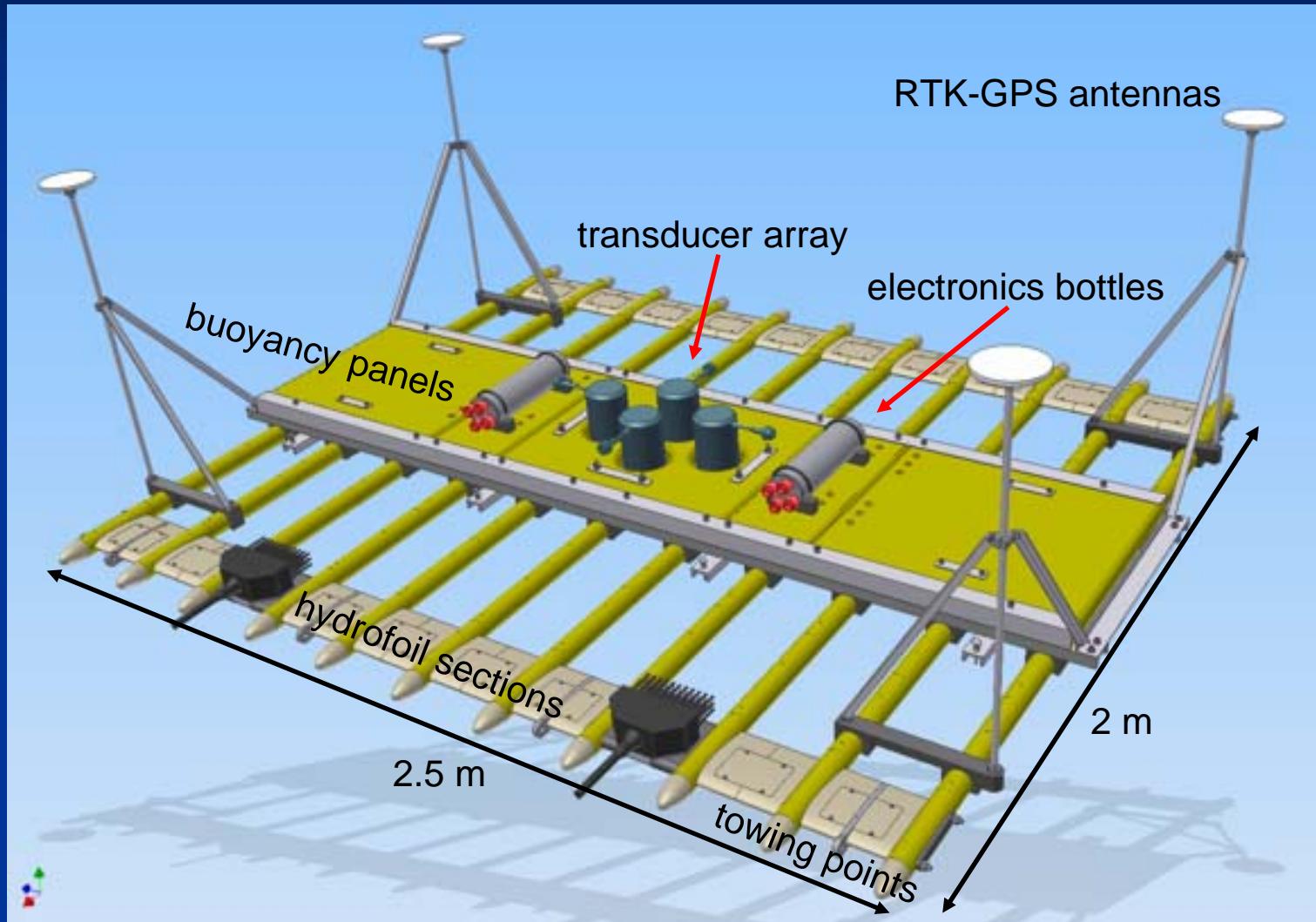
- *Source array*: high frequency sources
- *Receiver array*: adequately sample wavefield – avoid spatial aliasing
  - Reducing sampling grid spacing according to wavelength
  - Positioning accuracy of source and receiver components must be about a wavelength
    - in particular critical in z

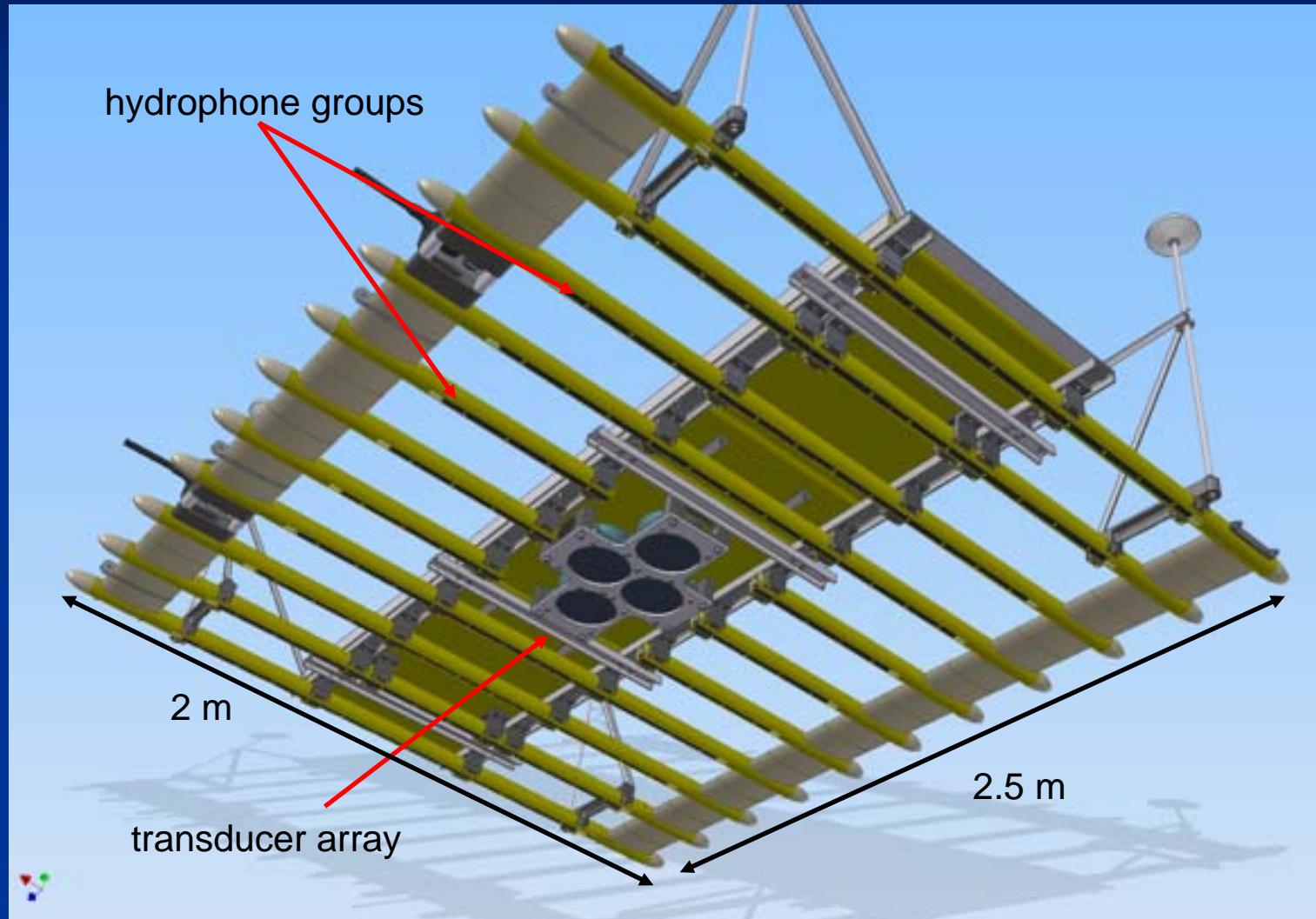


## 3D Chirp approach

*surface towed rigid frame housing all components*

- Source
  - GeoChirp II transducer array (4 transducers)
  - Bandwidth 1.5 – 13 kHz
  - Newly developed source signatures
- Receiver
  - 60 hydrophone groups,
  - Optimised geometry
  - 25 cm separation in x & y
- Positioning: RTK-GPS position and attitude





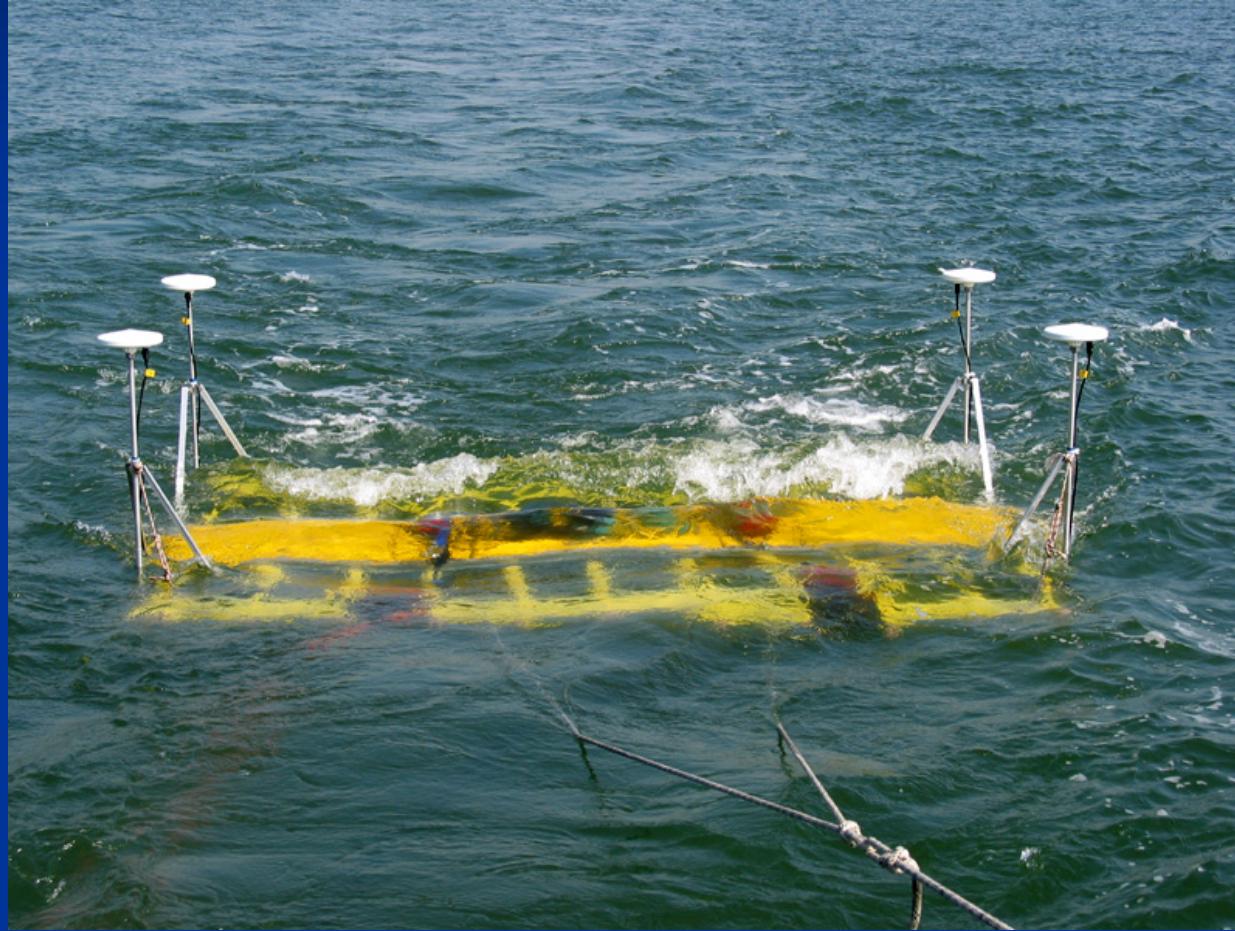


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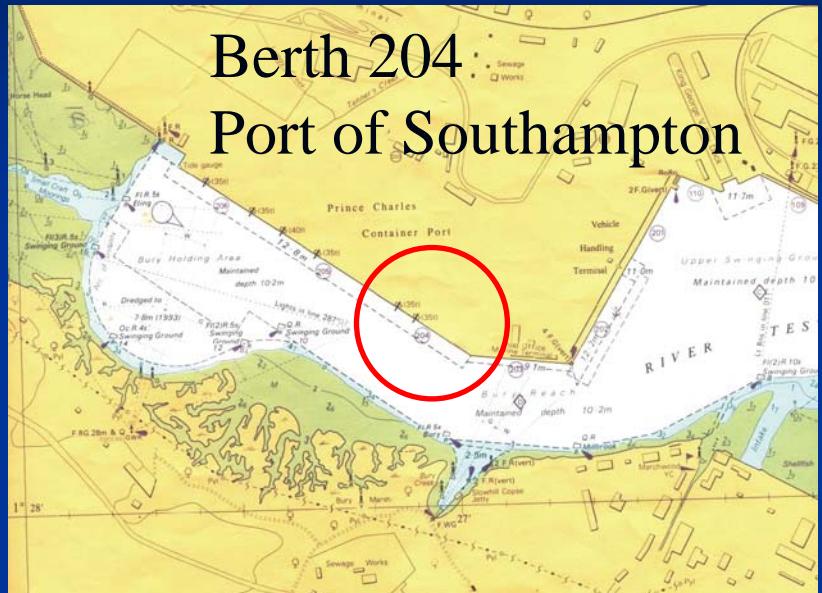


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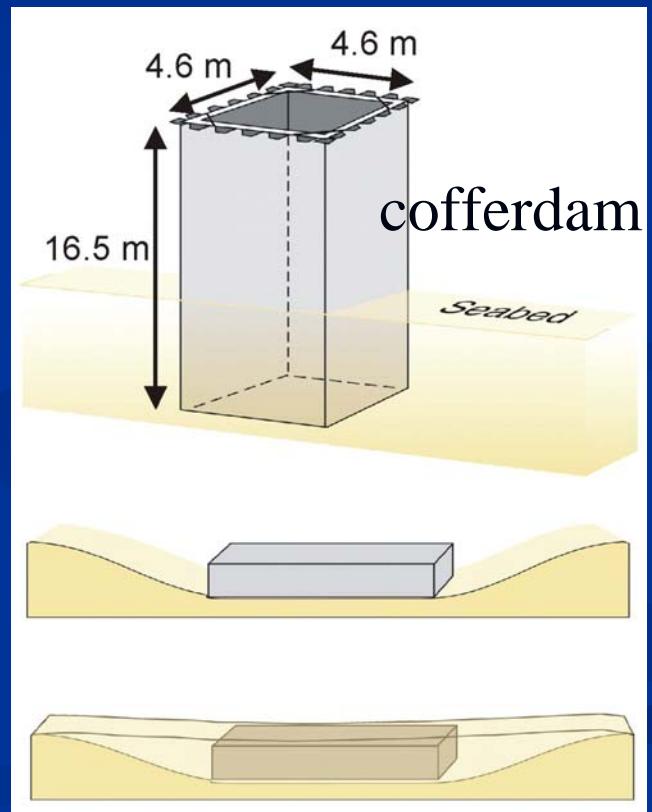


## Data processing

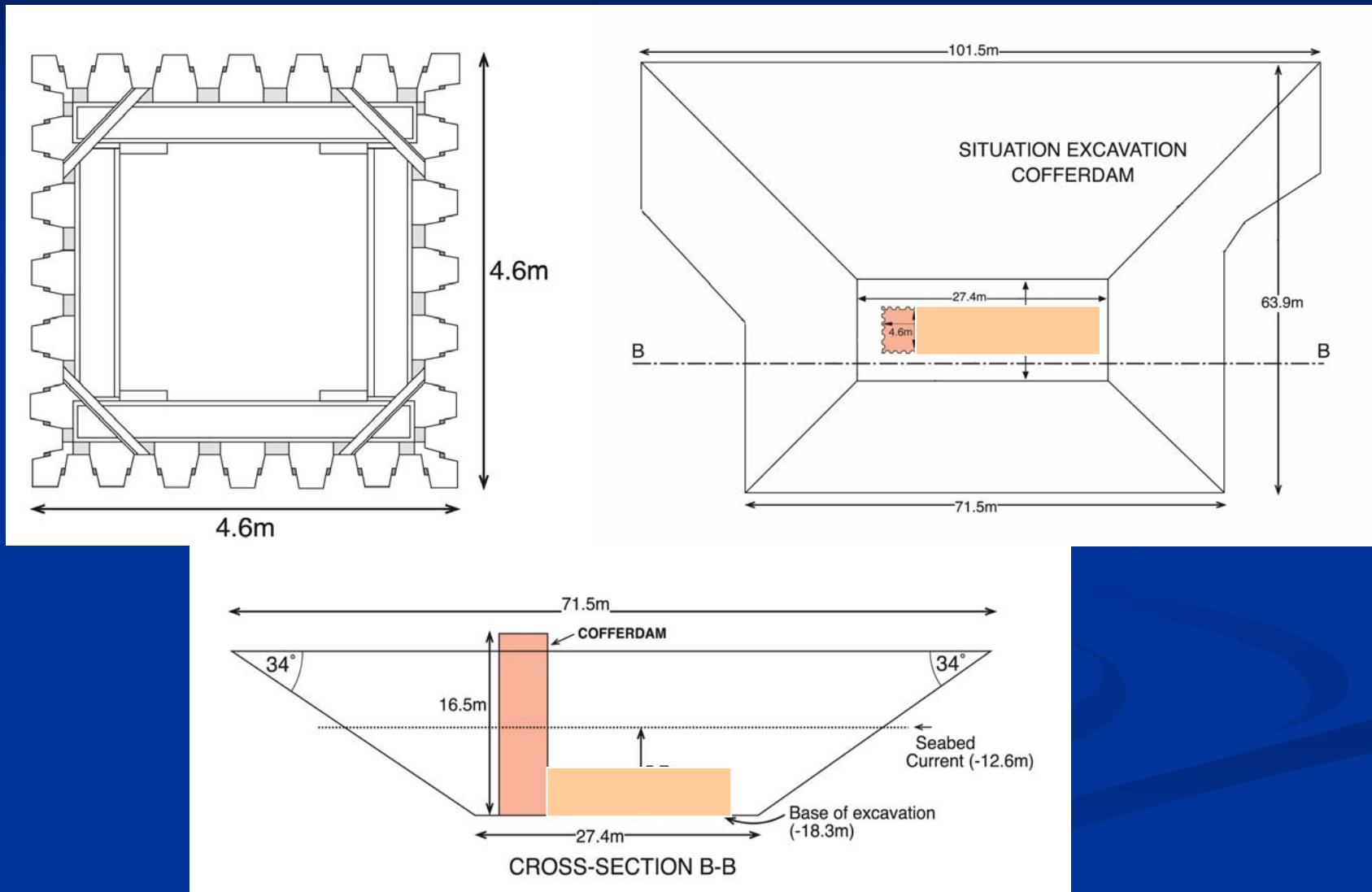
- Geometry processing
  - Combine seismic and navigation
  - Assign midpoints to grid
- Trace to trace processing
  - Filtering
  - Correlation
  - Instantaneous amplitude
- Mid-point binning OR
- 3D pre-stack Kirchhoff migration
  - Move reflection energy to correct location
  - Output to regular grid

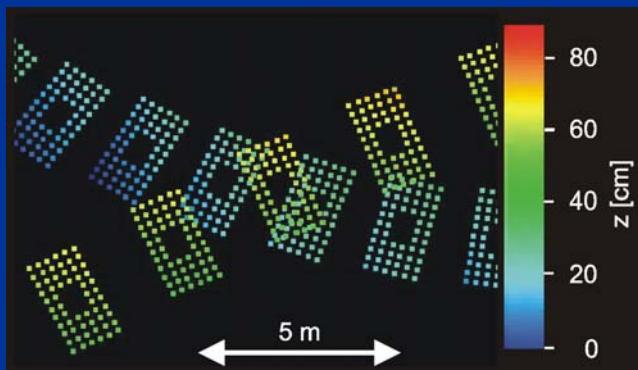
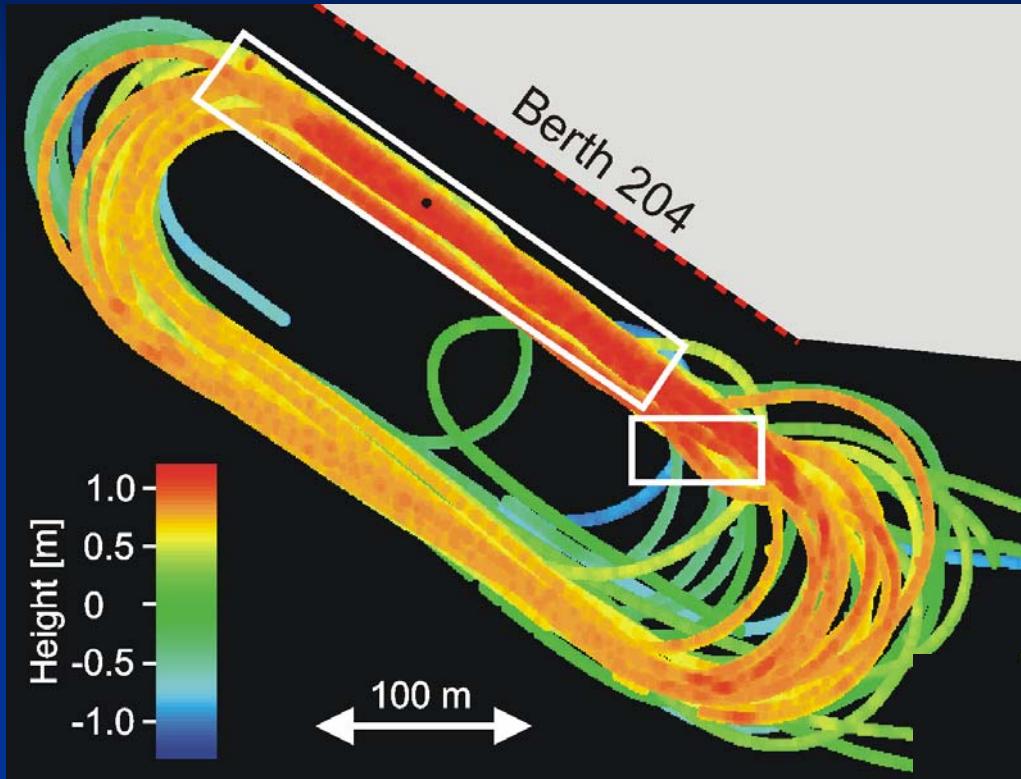


## Engineering case study



- Survey for Associated British Ports (ABP)
- Buried cofferdam – sheet steel construction – used prior to development of container port

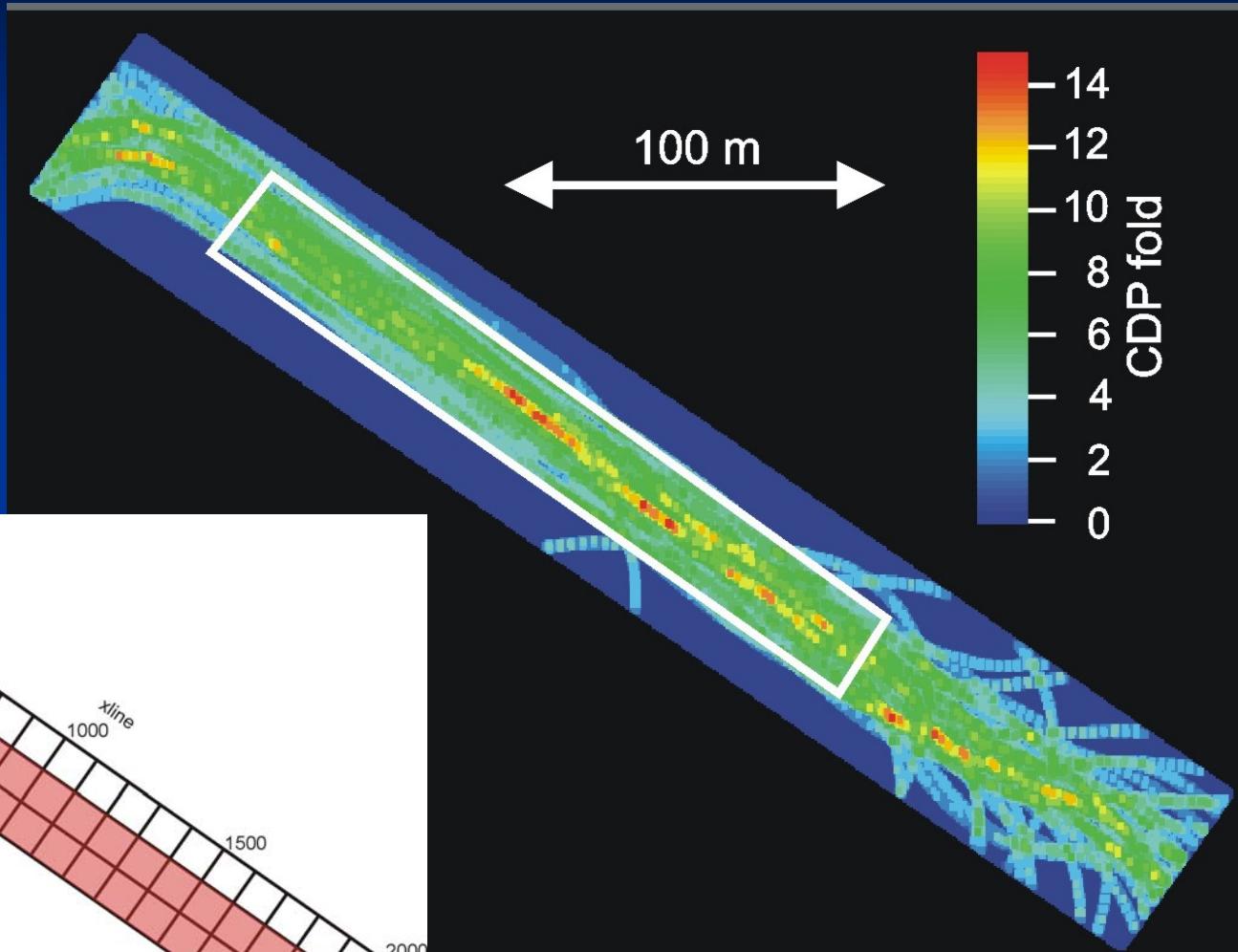
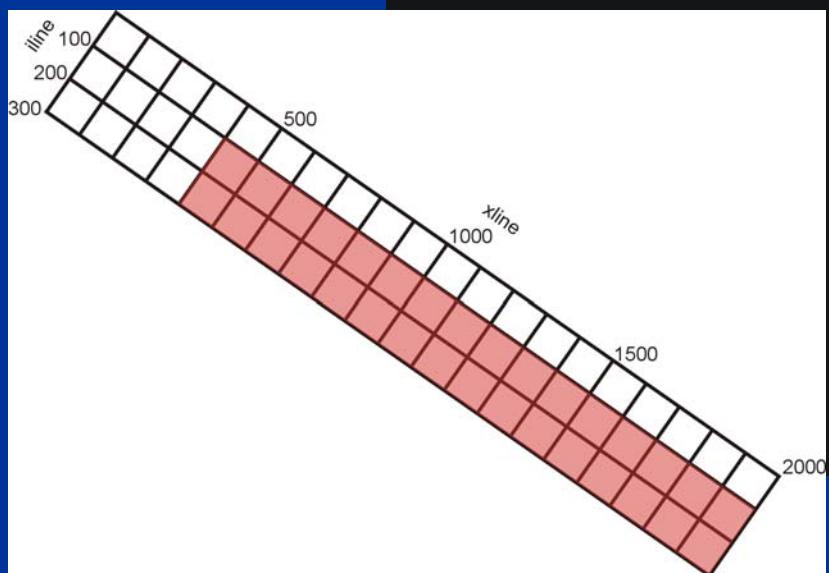


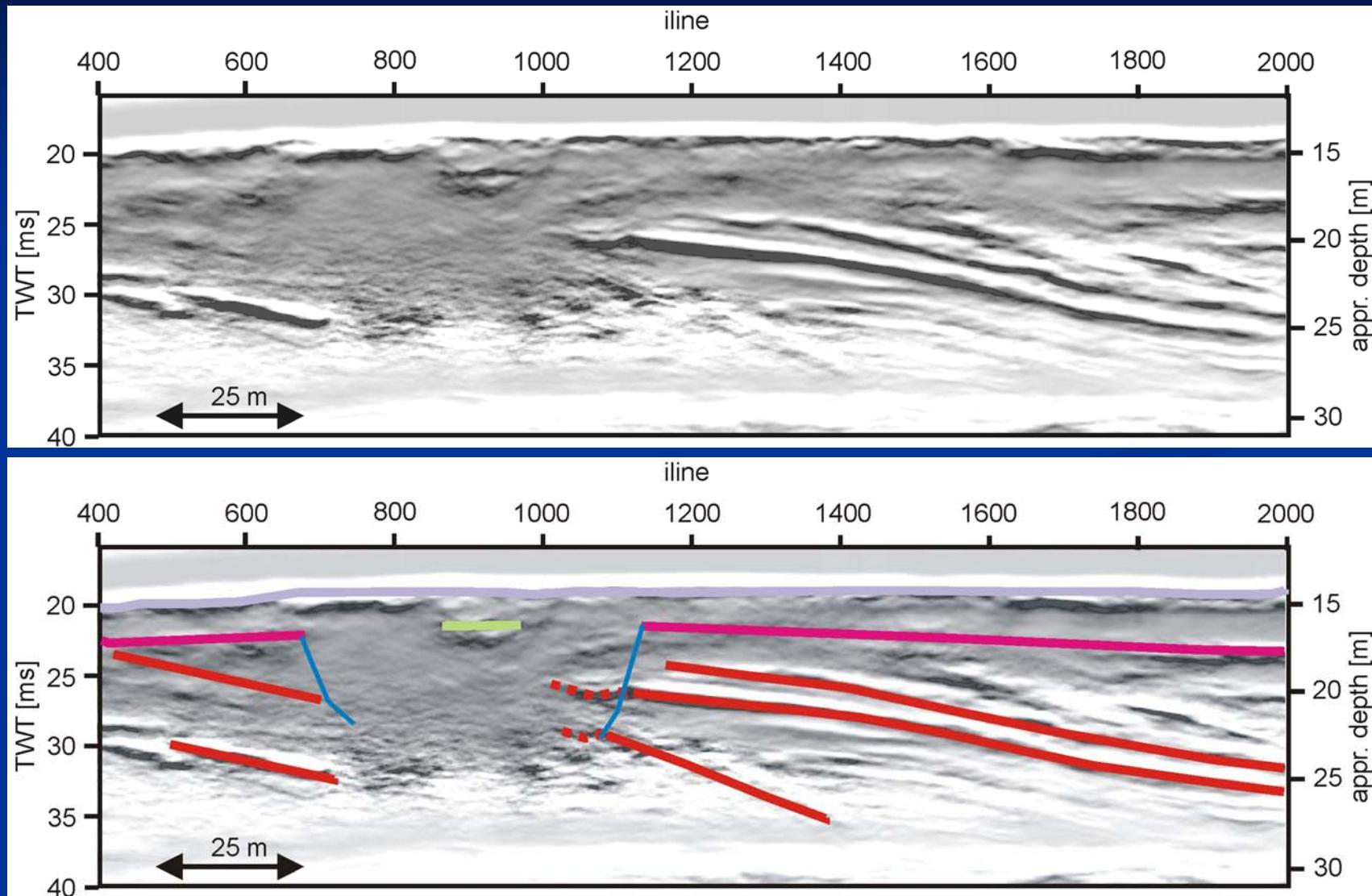


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## Navigation control

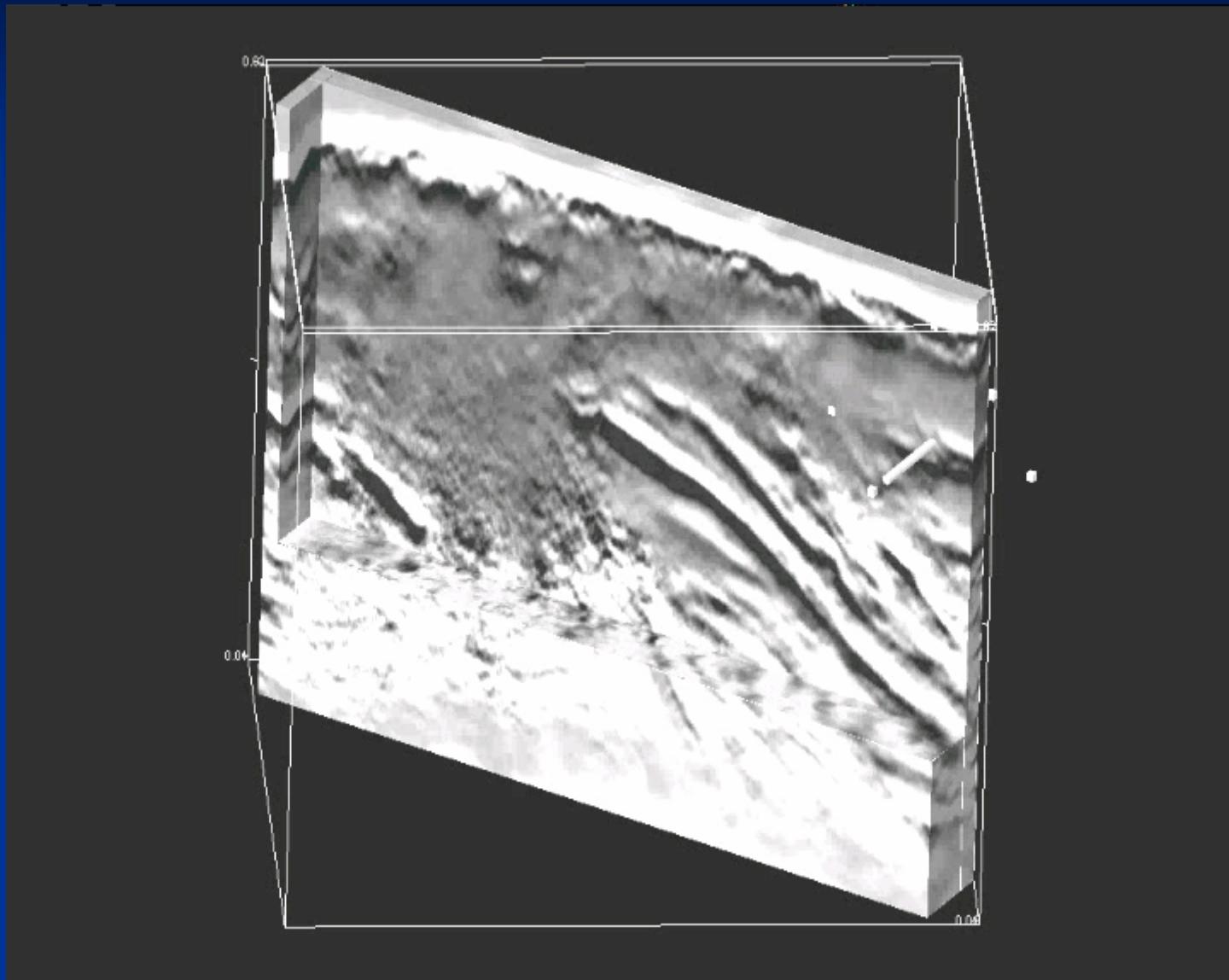




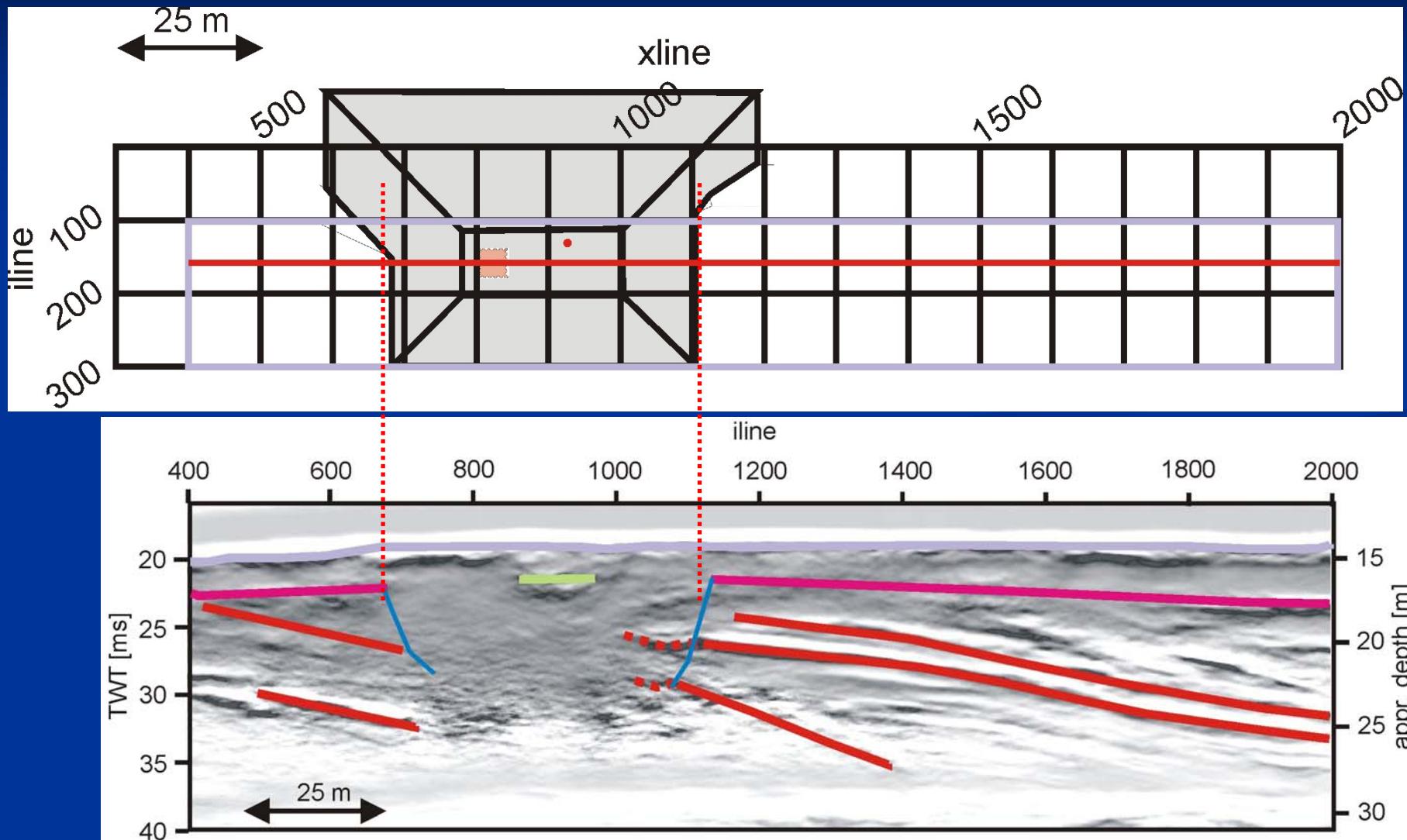


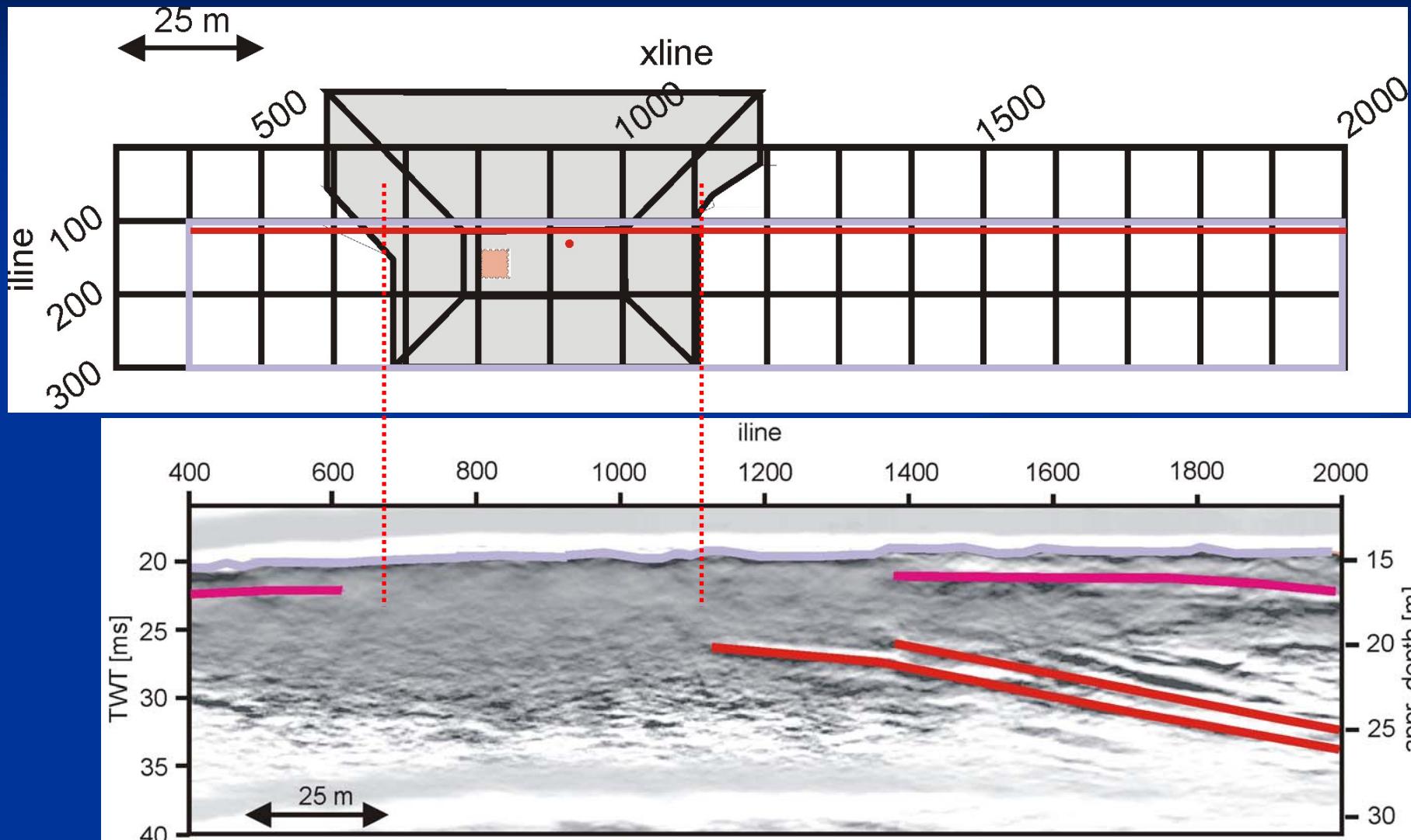


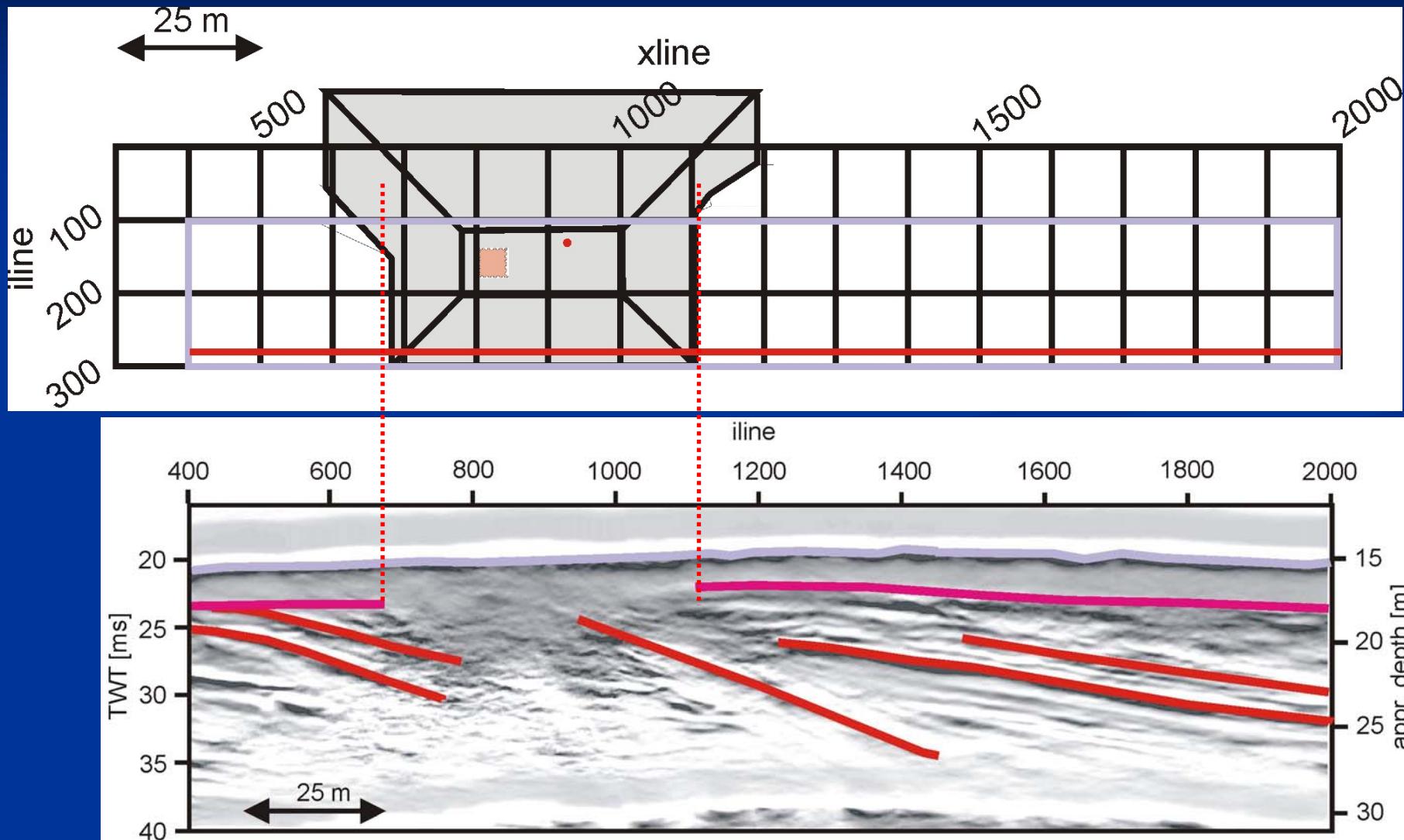
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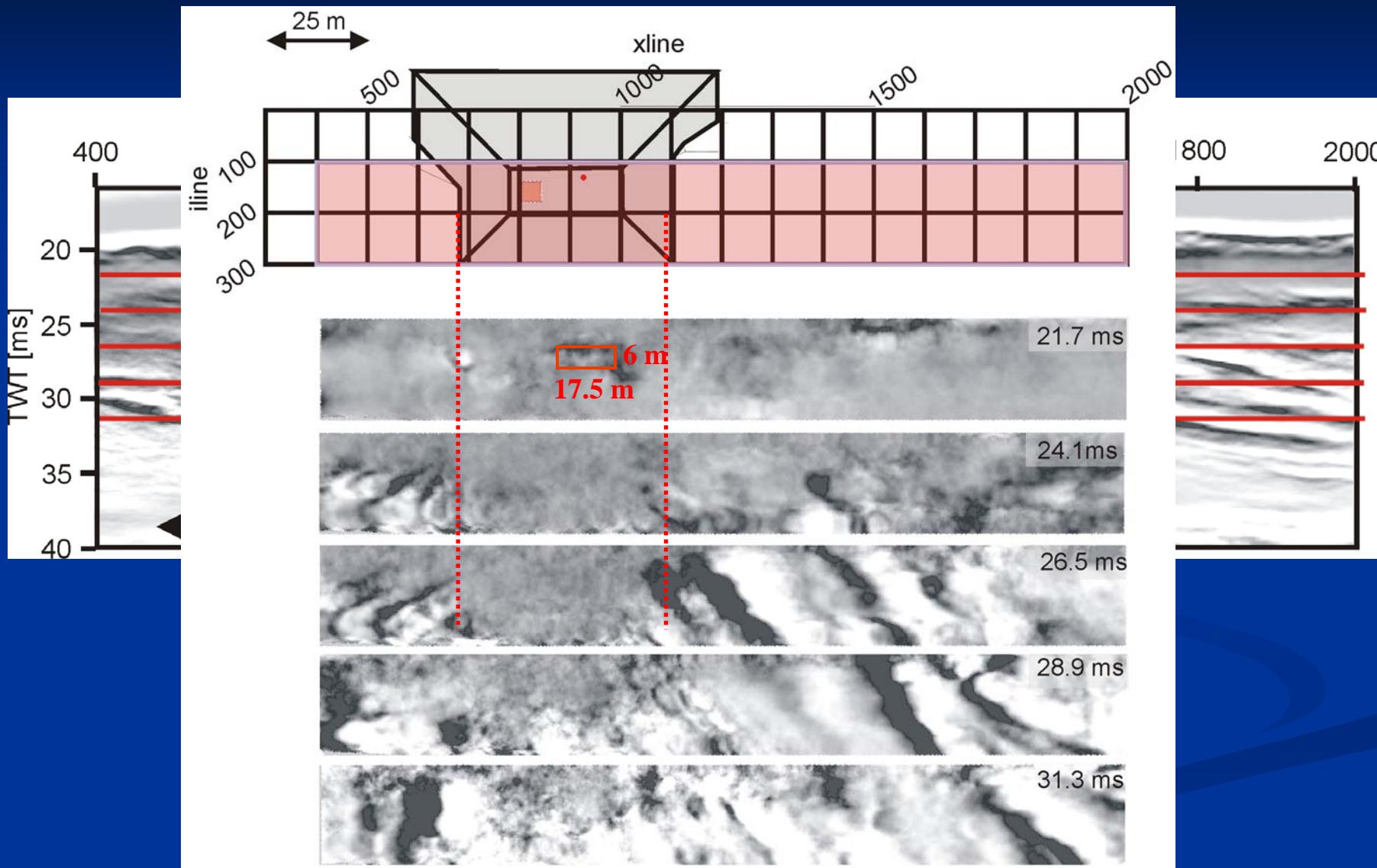


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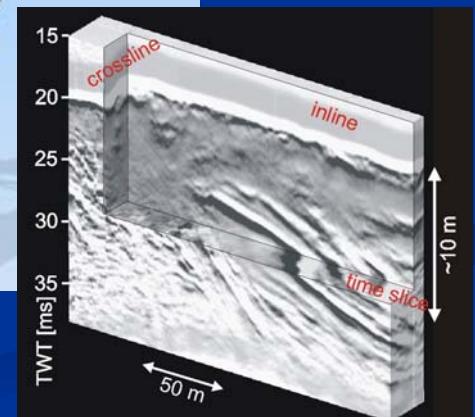
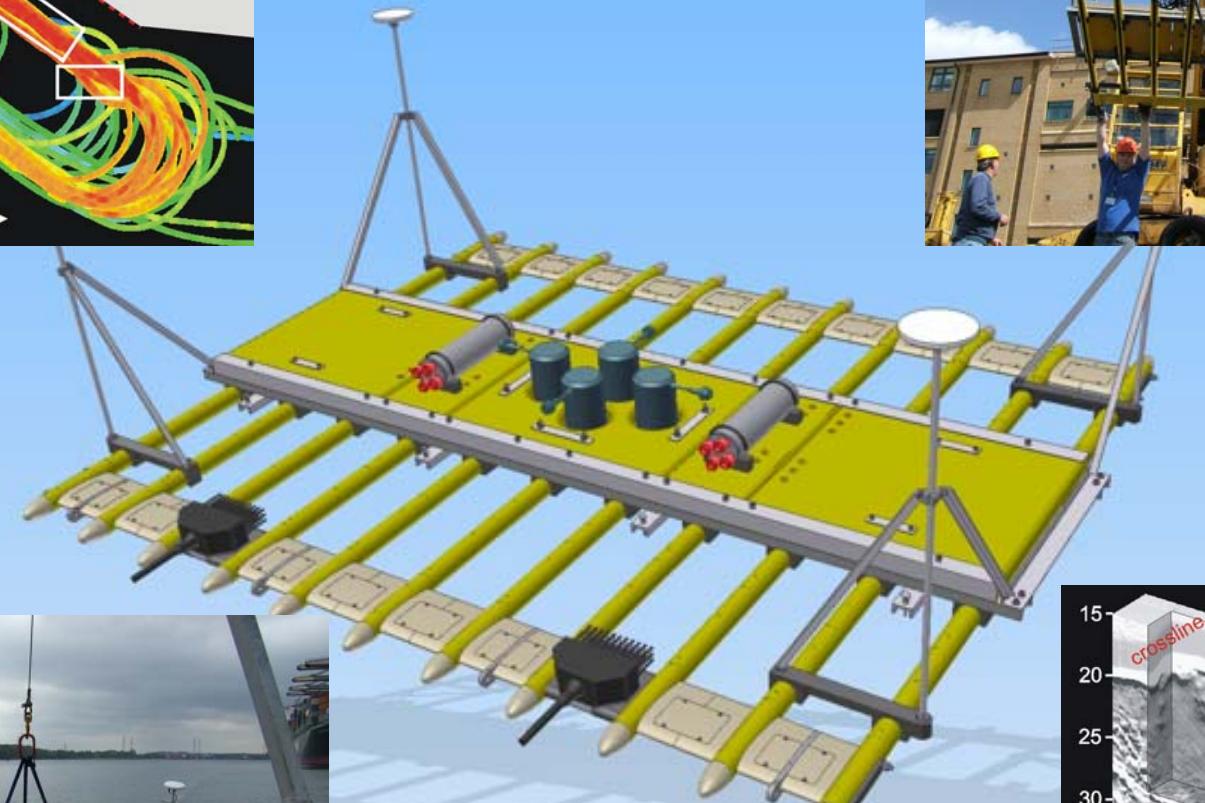
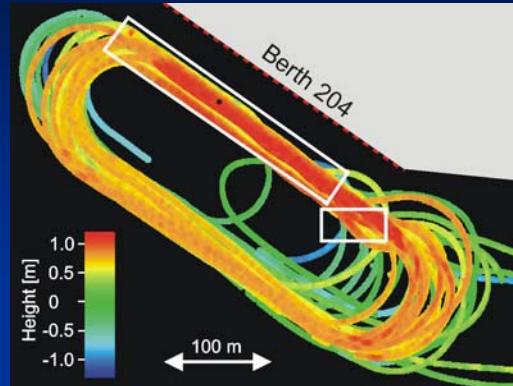


## Conclusions

- We image the trench used to bury the Cofferdam as a chaotic zone cut down into layered bedrock.
- We have interpreted a reflection horizon at depth of 1.6 m of 17.5 m length and 6 m width. We interpret this to be the top of deformed cofferdam (known dimensions 16.5m • 4.6m • 4.6m)
- GeoChirp 3D is the first 3D high resolution sub-bottom profiler with kHz bandwidth
  - Commercially available
  - Applicable to problems in
    - Marine Engineering
    - Marine Geology
    - Customer Driven Further Developments
    - Marine Archaeology
    - Defence



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