Versatile acquisition of low-fold, high-resolution 3D seismic data: the *PCable* system

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National Oceanography Centre, VBPR, UiT, Fugro

Lamont, 3D seismic workshop

Volcanic Basin Petroleum Research

National Oceanography Centre, Southampton
UNIVERSITY OF SOUTHAMPTON AND NATURAL ENVIRONMENT RESEARCH COUNCIL

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FUGRO

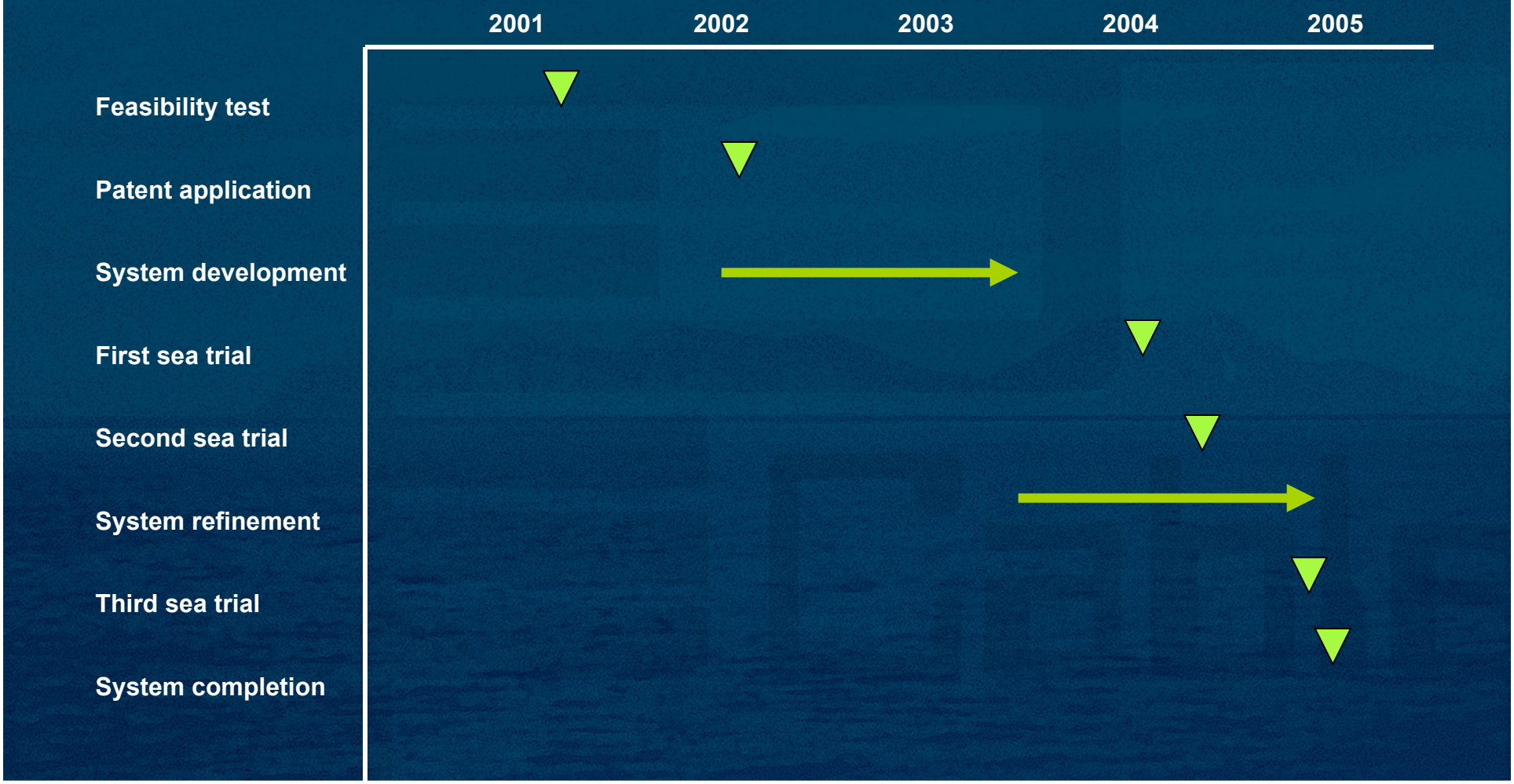
Overview

- Development project
- System overview
- Trial data from offshore Svalbard
- Future developments and possibilities for collaboration

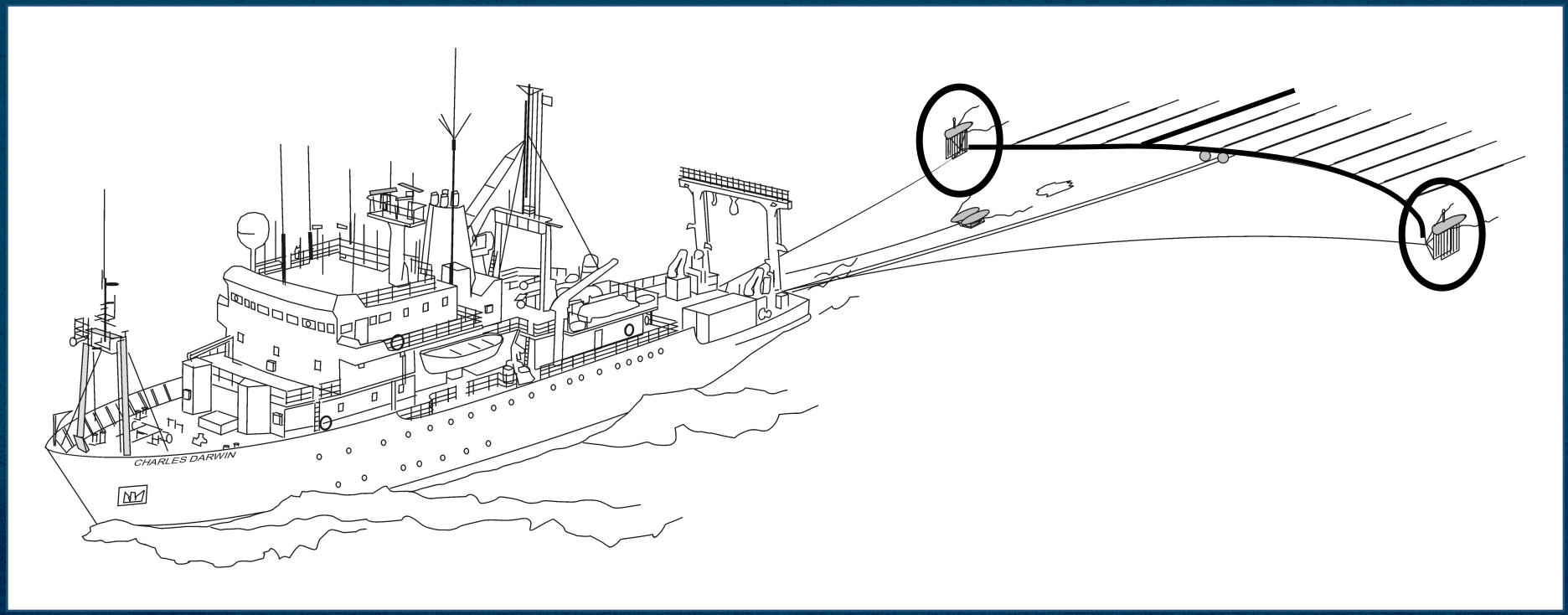
PCable partners

- Volcanic Basin Petroleum Research AS: Project management, Processing, Sea Trials
- Southampton Oceanography Centre, System Development, Processing, Sea trials
- University of Tromsø, Sea Trials, Processing
- Fugro Survey AS, Marketing, Technical support

Project timeline



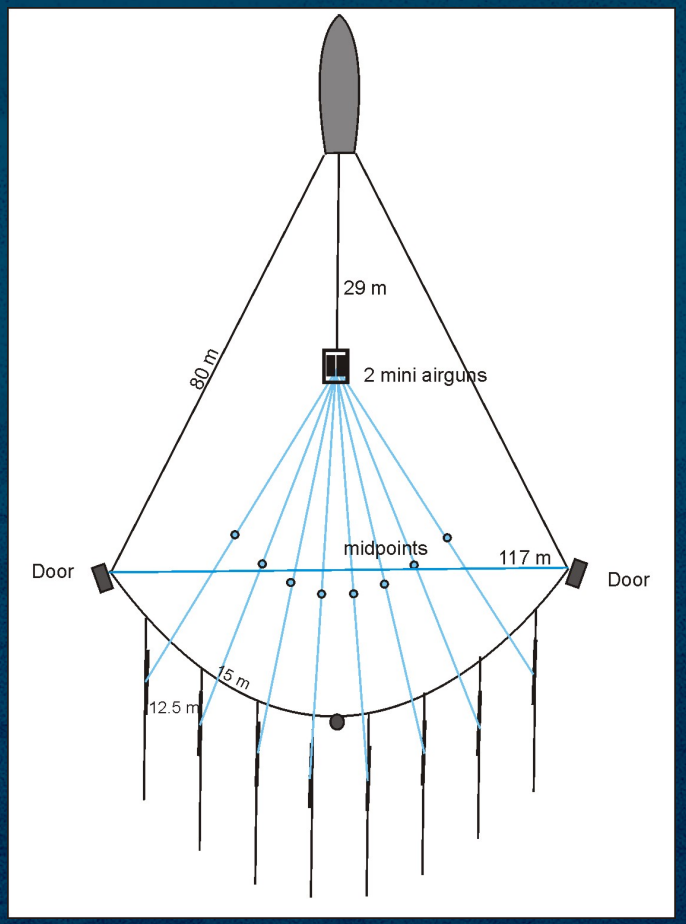
PCable concept



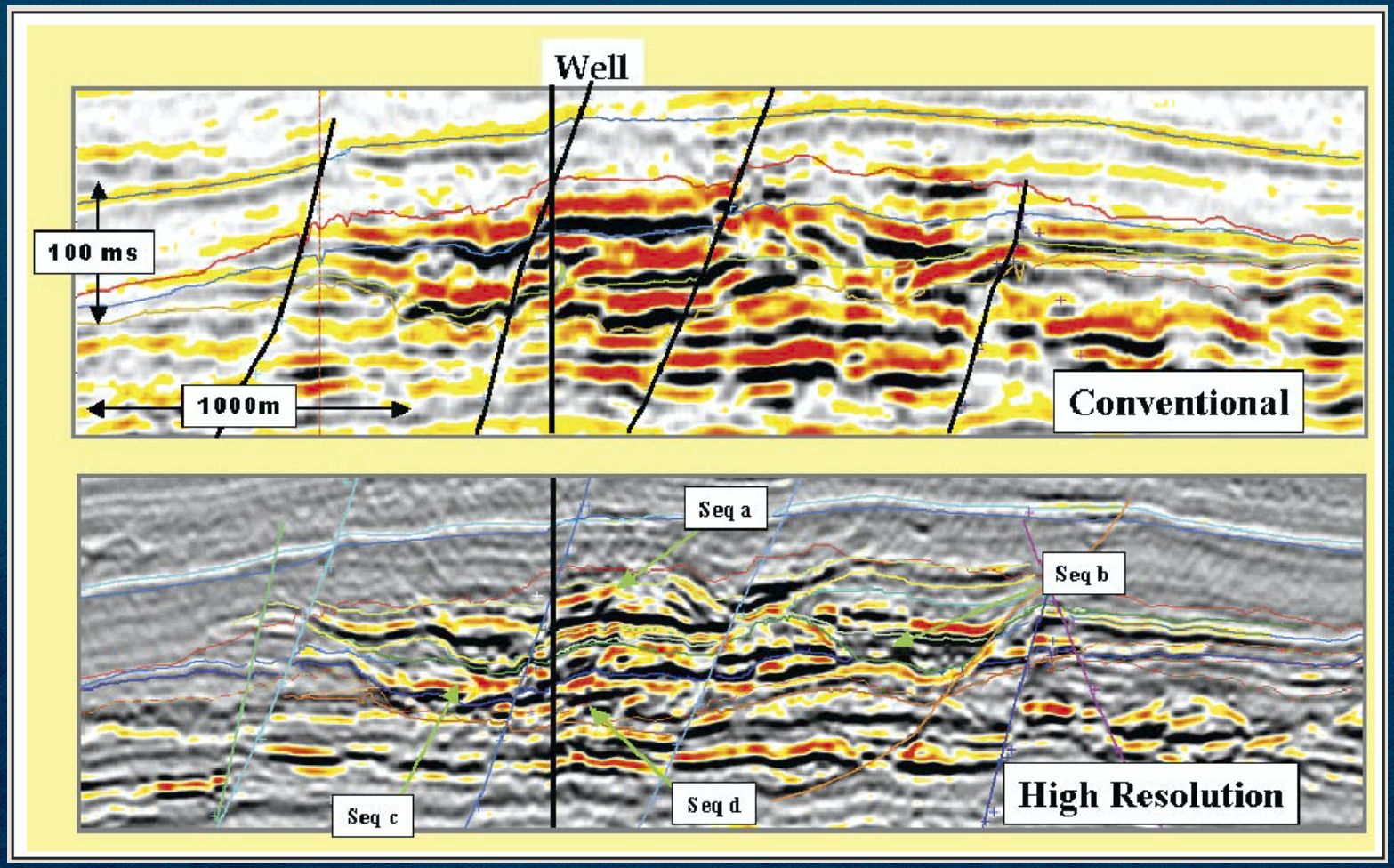
- A seismic cable towed perpendicular to the vessel's steaming direction
- Many single-channel seismic streamers attached to a wire held in place by two doors

Technical specifications

- 8 single channel streamers
- 6.25 m inline separation
- Full migration possible up to 250 Hz ≅1.5 m resolution
- Single source with 2 mini airguns (2 x 40 in^3)



Hi vs. lo resolution



after Beydoun et al., 2002

PCable capabilities

- Fast deployment from most types of research and industry vessels (1-2 h)
- Imaging above the first sea floor multiple
- Configuration target- and vessel-dependent. Typical figures:
  - 10 to 500 km^2 survey areas
  - 200 to >3000 m water depth
  - 10 m spatial resolution
  - 1.5 m vertical resolution (250 Hz)

Industrial applications

- Drill site investigations
- Sea bed properties for offshore installations
- Geohazard assessments
- 4D seismic monitoring
- Deep-water exploration

Research applications

- Scientific drilling (site surveys, core-log-seismic integration)
- Fluid migration (3D, 4D)
- Deformation and faulting
- Mass movement (erosion, transport and deposition)
- Paleooceanography and paleoclimatology

Examples – 3D and 4D imaging

Fluids and fluid migration

- Shallow gas
- Gas hydrates
- Seeps
- Mounds and mud volcanoes

Structures

- High-resolution imaging of fault systems
- Slumps and slides
- Tertiary dome structures on the North Atlantic margins

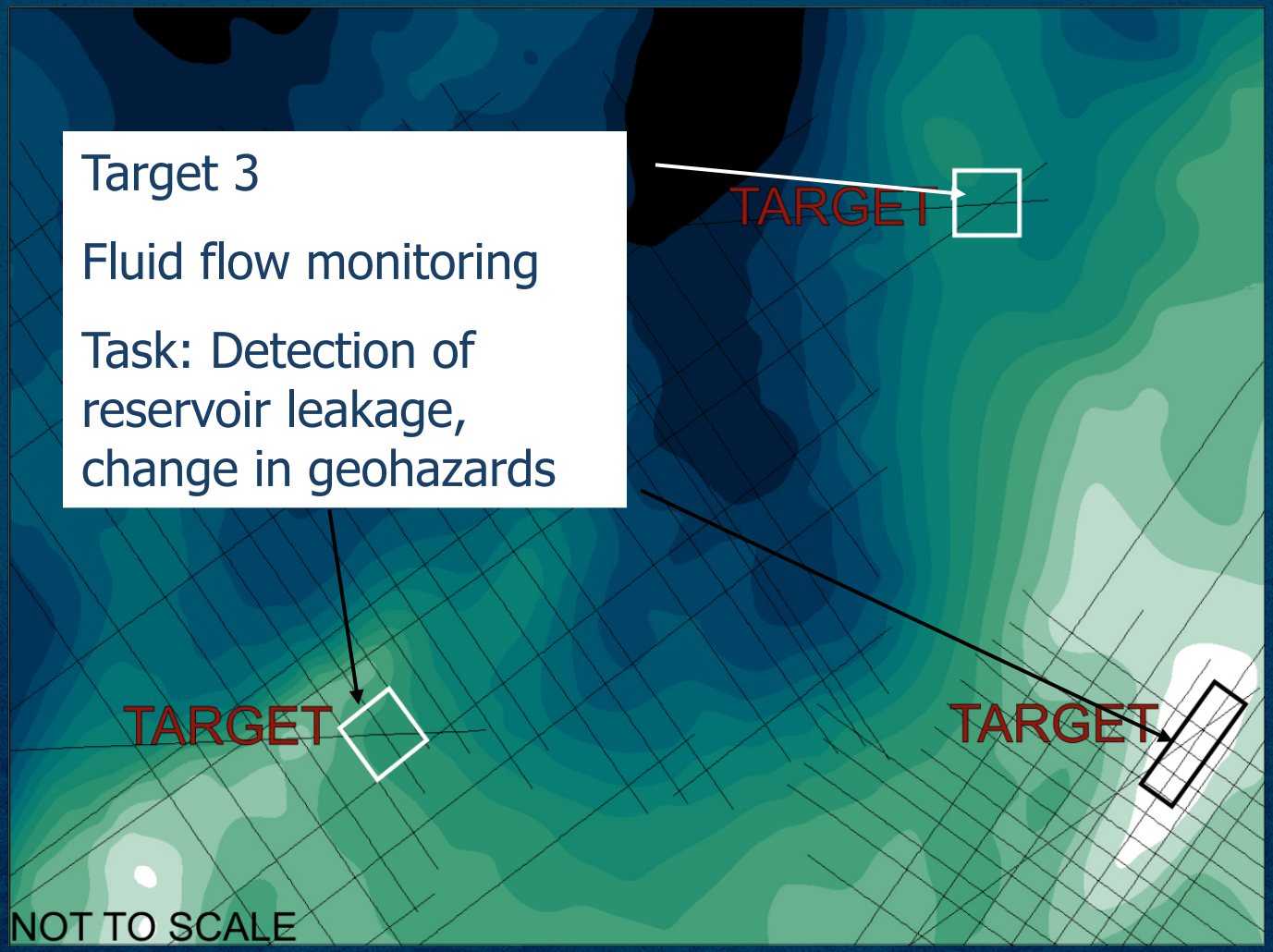
Sedimentary facies variations

- Channels
- Carbonate reefs
- Thin-layer stratigraphy (modern analogues)

Core-log-seismic integration

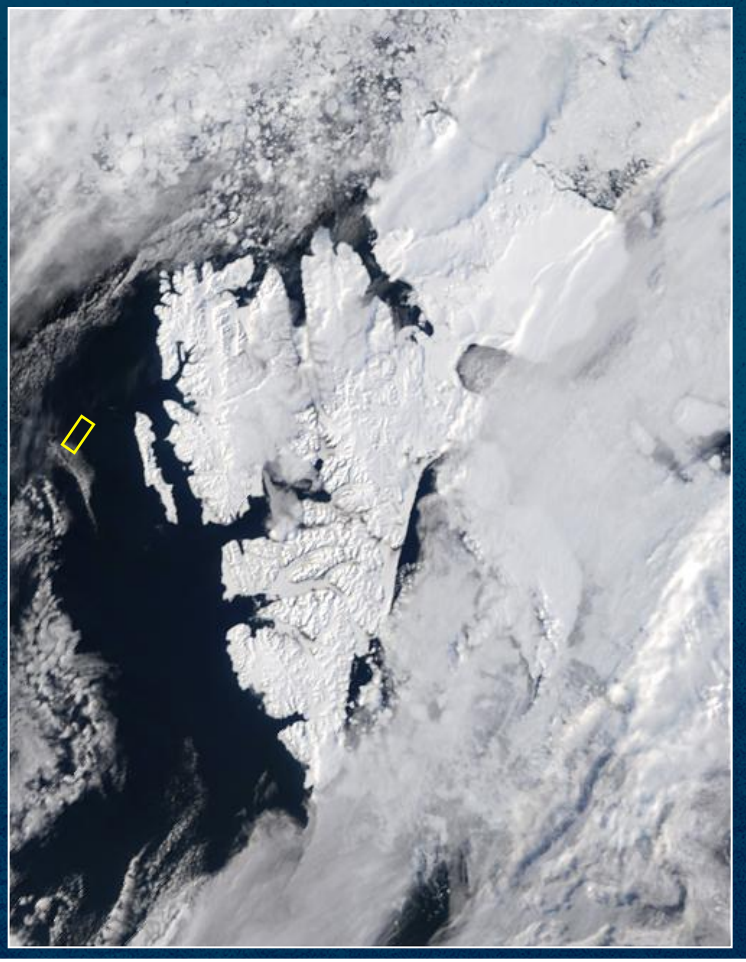
- Research boreholes (ODP, IODP)
- Geotechnical boreholes
- Exploration and production boreholes

“Intelligent & Versatile”



2nd trial survey off Svalbard

- Background
- Acquisition
- Processing
- Results/data



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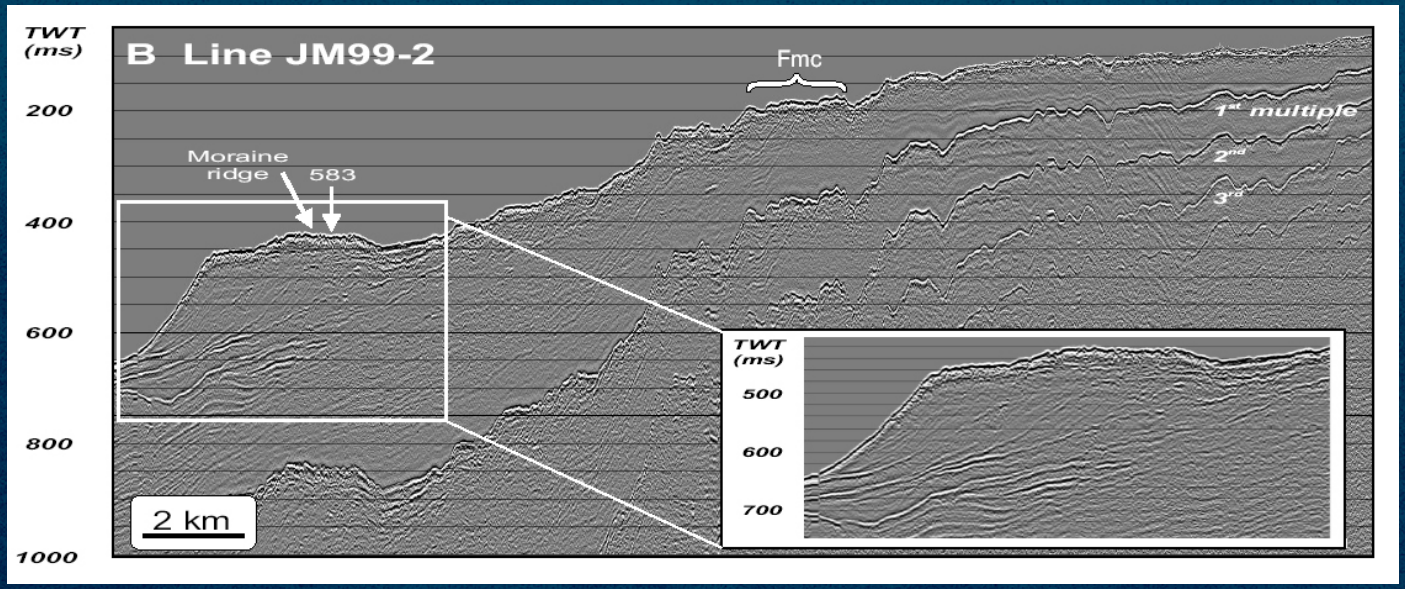
Project background

- The second trial survey was acquired as a part of the NFR strategic university project (SUP) “Slope Stability” headed by Prof. Jürgen Mienert, UiTø

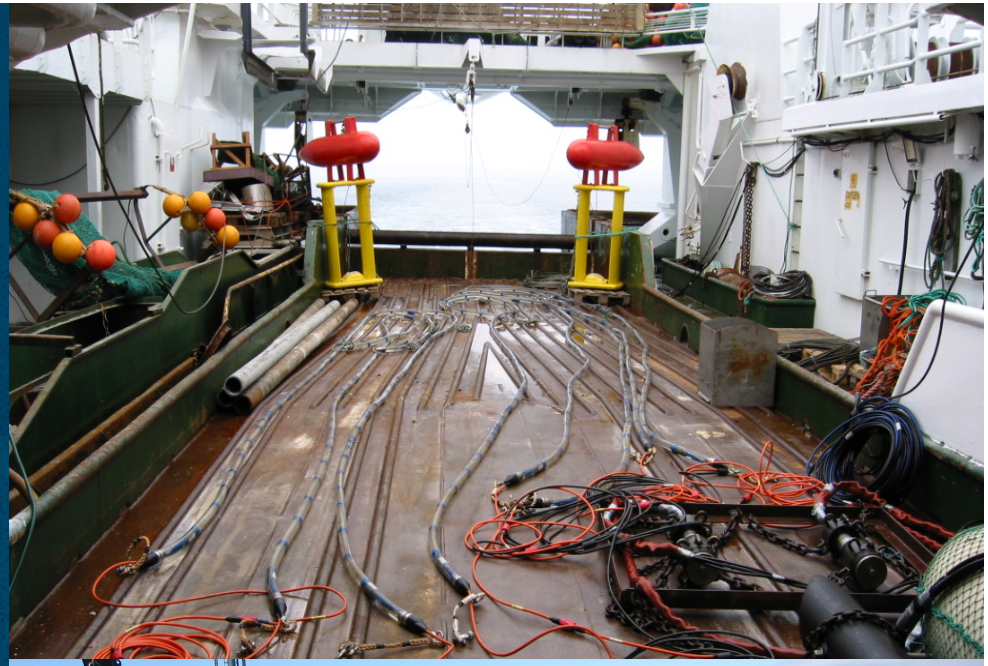
- The purpose of the survey was to image initiation of submarine slope failures in glacial moraine sediments northwest of Prince Karl’s Foreland, Svalbard



Previously acquired 2D single-channel seismic data from the study area

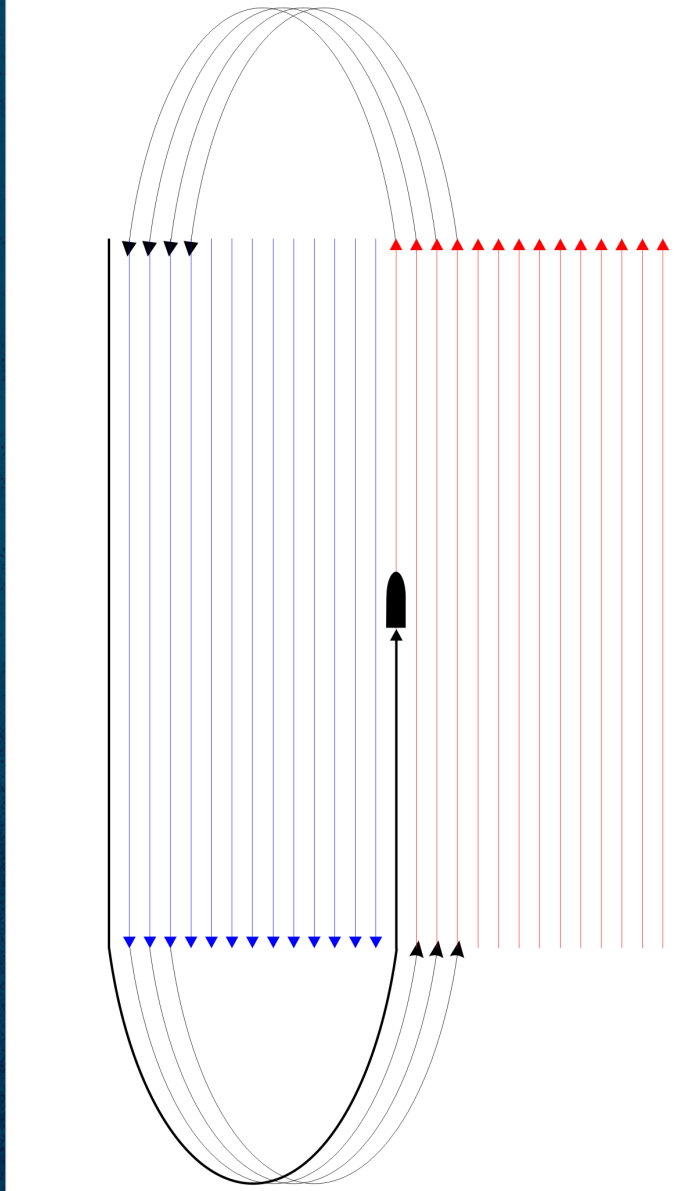
R/V Jan Mayen

- Length OA: 63.8 m
- Beam: 13 m
- Gross tonnage: 2052 tonnes
- Trawler – high propeller noise



Production

- Vessel speed: 3.3 kn
- Shooting time: 100 h
- Survey size: 1.3 x 16 km
- Deployment/recovery: 2 h
- Production rate: 5 km^2/day. Fully operational up to 25 km^2/day



Receiver system

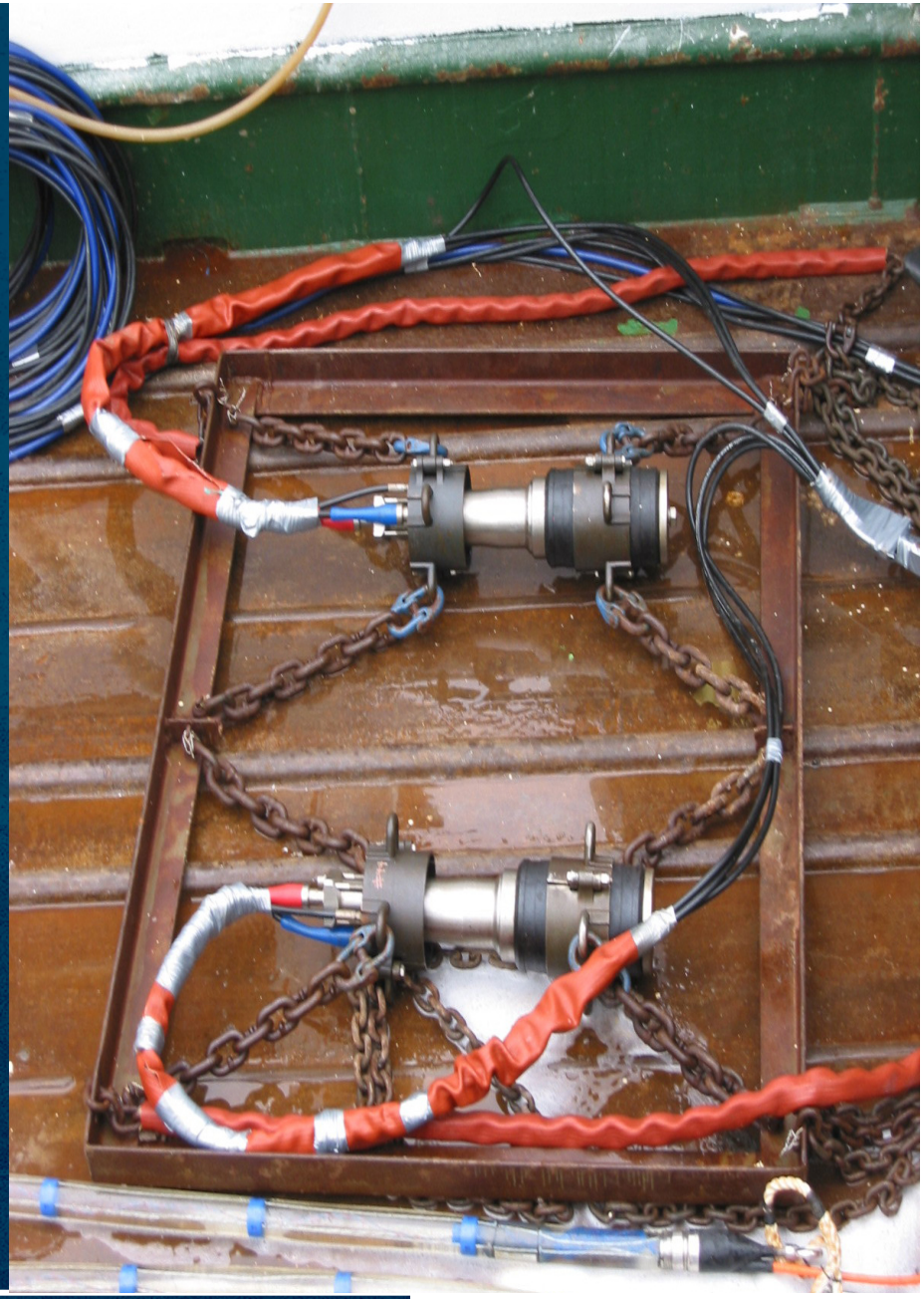
- Single-channel analogue mini streamer with 11 hydrophones
- Spacing: 15 m (12.5 m effective)
- Frequency response: 8 – 10000 Hz
- Towing depth: ~1 m
- Swath width: 50 m

Deflectors

- Pulling force: 800 N
- Buoyancy: 400 kg
- Height: 220 cm
- Weight: 200 kg
- Material: PVC

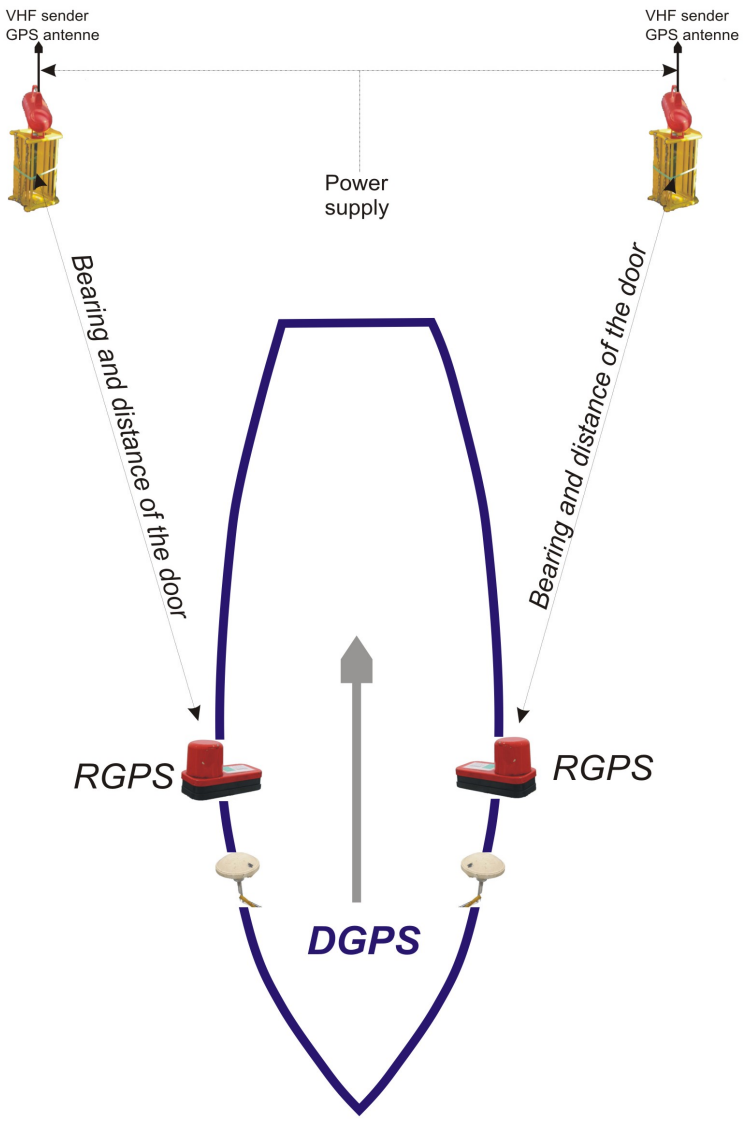
Seismic source

- Sleeve guns
- Volume: 2 X 0.6 l
- Towing depth: 4 m
- Signal: 30-450 Hz
- Dominant signal: 100 Hz
- Compressor firing every 12.5 m



Navigation system

- DGPS receiver on ship with accuracy of 5 m
- RGPS on the doors with relative accuracy of 0.15 m



Recording System

- Geometrics Geode24®
  - 24 channel digital recording system
- Seismodule® controller software running on a Windows XP® laptop

Processing

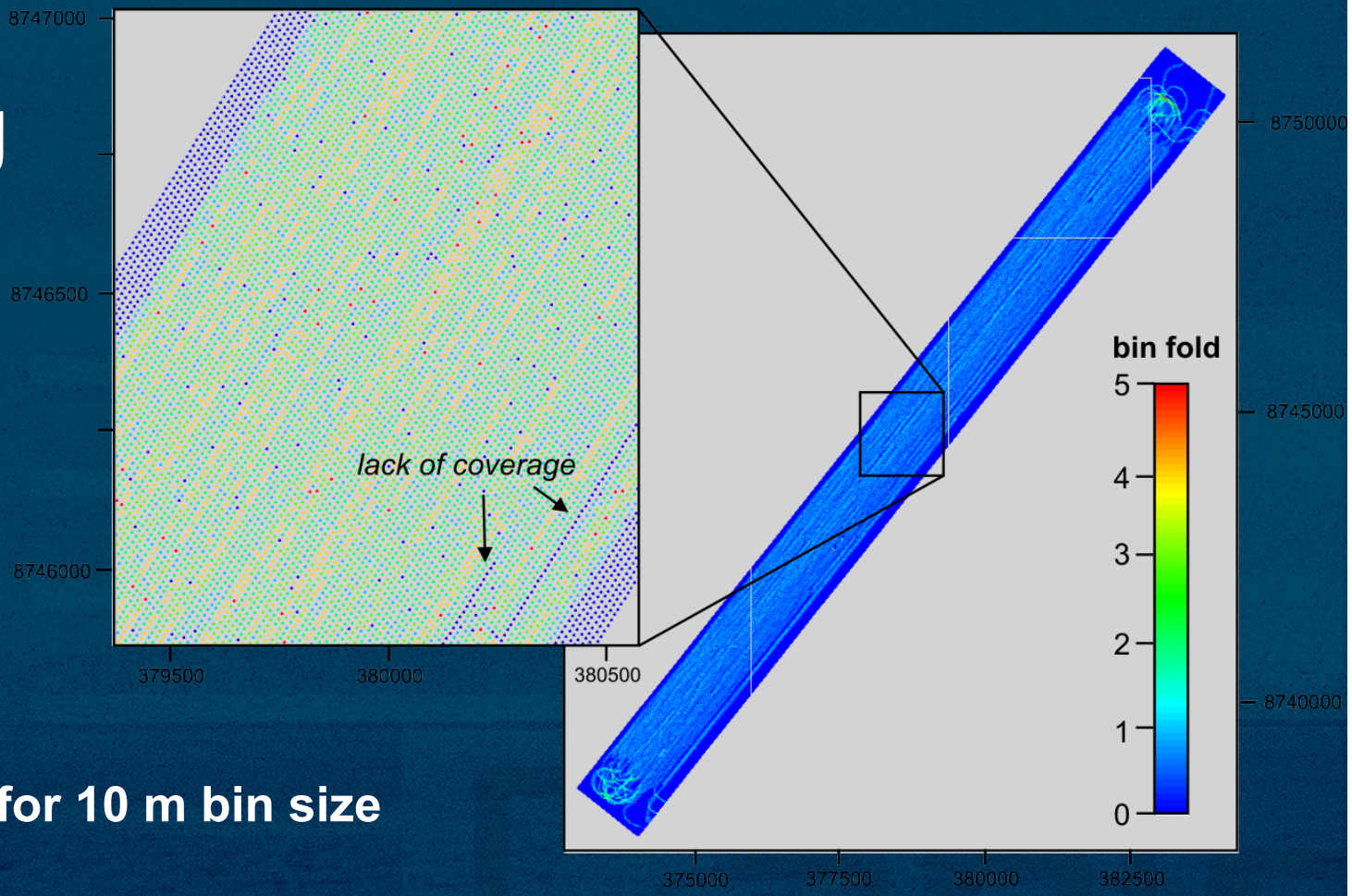
Geometry

- Navigation processing
- Binning

ProMAX processing flow

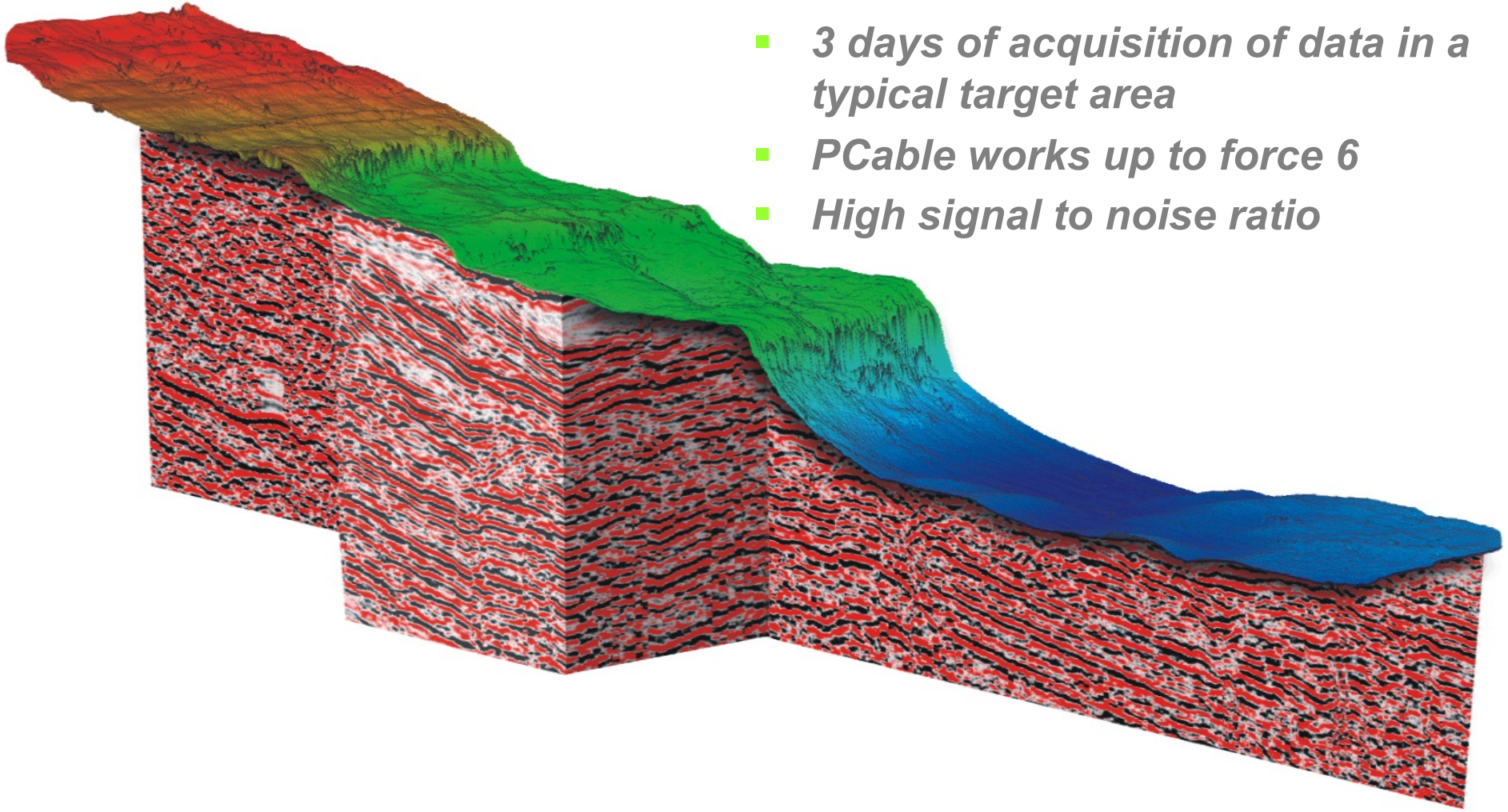
- Conversion to SEG-Y
- Navigation loading
- Flex binning
- Residual statics corrections using multi-beam bathymetry data
- Frequency filter
- Ensemble balancing
- (Time migration)
- AGC
- SEG-Y export

Binning



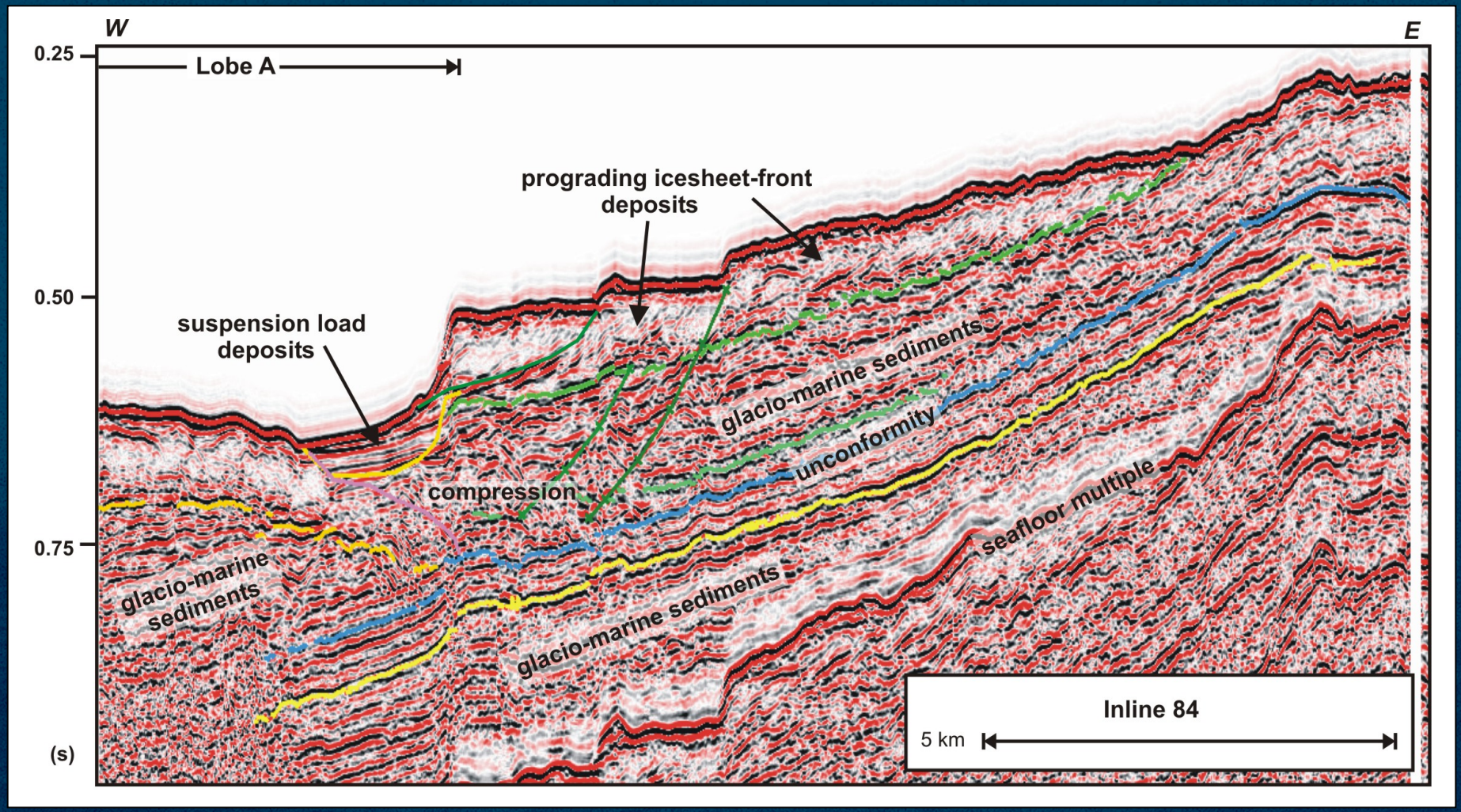
- Seismic fold for 10 m bin size
- Good coverage – up to 5 traces in each bin

Initial results



- *3 days of acquisition of data in a typical target area*
- *PCable works up to force 6*
- *High signal to noise ratio*

Preliminary results



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Scientific usage plans

- Cruise to investigate mud volcanoes in the Gulf of Cadiz as a part of the EU-funded HERMES project later this year
- Two more surveys funded through the Norwegian Science Council to investigate focused fluid flow on the Norwegian Margin in 2006
- Two cruises funded through the Seabed Project (industry consortium) in 2006/2007

Development plans

- Upgrade prototype PCable to a12 digital streamer system
- Develop a 24-channel digital streamer system that is containerised and is still easier to launch
- Acquire a HiRes3D in a license area with conventional 3D seismic data

Conclusions

- The PCable - a flexible and efficient new seismic tool for industry applications and marine geological research
- Use the PCable HiRes3D data in mature areas to increase drilling and platform safety and decreases drilling and construction cost due to better knowledge of the sub sea-bed geology
- Conduct time-laps (4D) monitoring of fluid movements and deformation
- Collaboration possible for all scientific purposes – perfect for IODP site surveys and any research objectives that require 3D control of the upper 500 m of sediments