Finding the needle in the hay stack - tracing seabed gas seepages using hullborne multibeam echo sounder, and AUV based sonar and optical systems

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NGU
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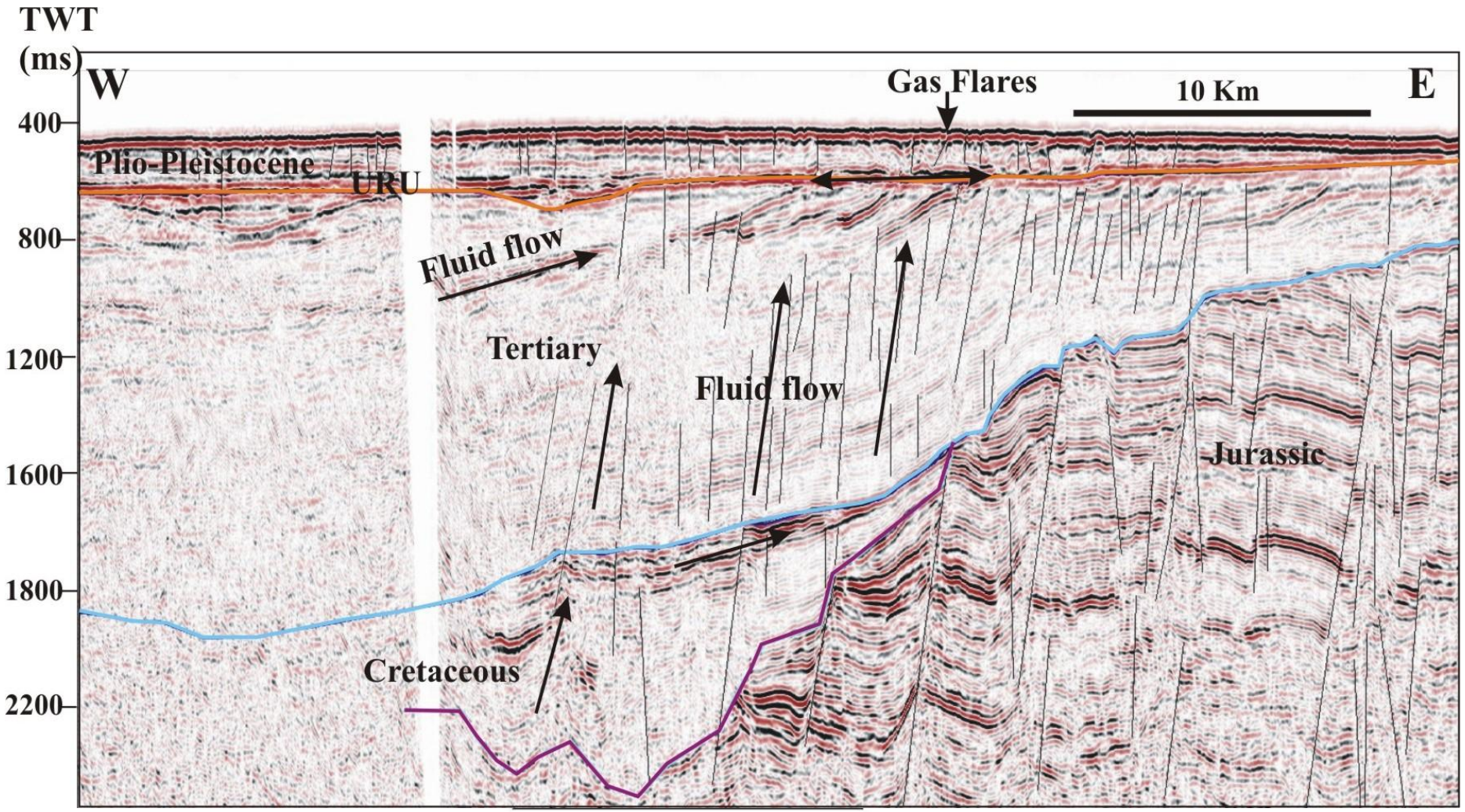
Geological Survey of Norway

Lundin

Forsvarets forskningsinstitutt

Scientific objective

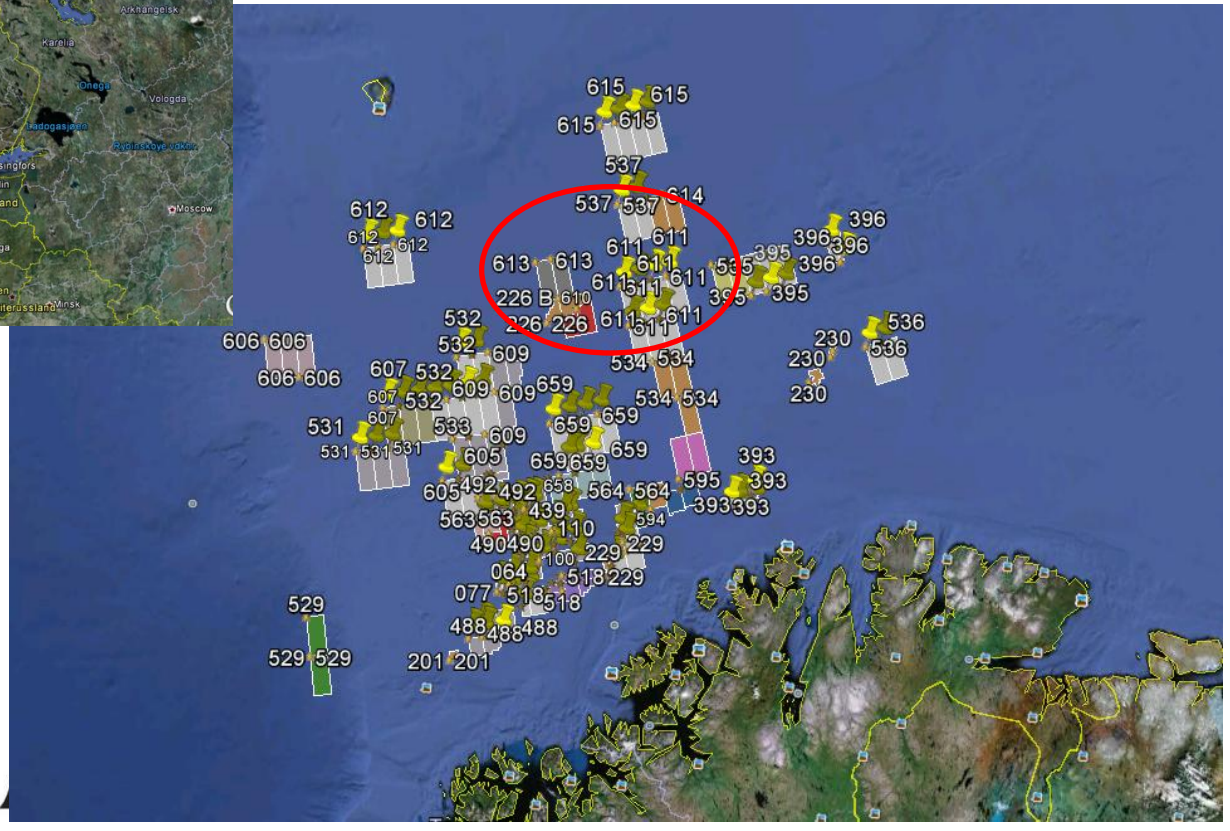
A better understanding of the shallow geological systems in the Barents Sea with particular attention to fluid flow



Specific objectives

- Identify regional spatial distribution of gas flares within an area of 3000 km2 in the Barents Sea
- Identify and describe associated structures (i.e. pockmarks, carbonate reefs) using geomorphology
- Document associated structures with visual tools
- Determine present activity (gas bubbling, bacterial mats)
- Sample seep related material (crusts, gas, mats sediments)

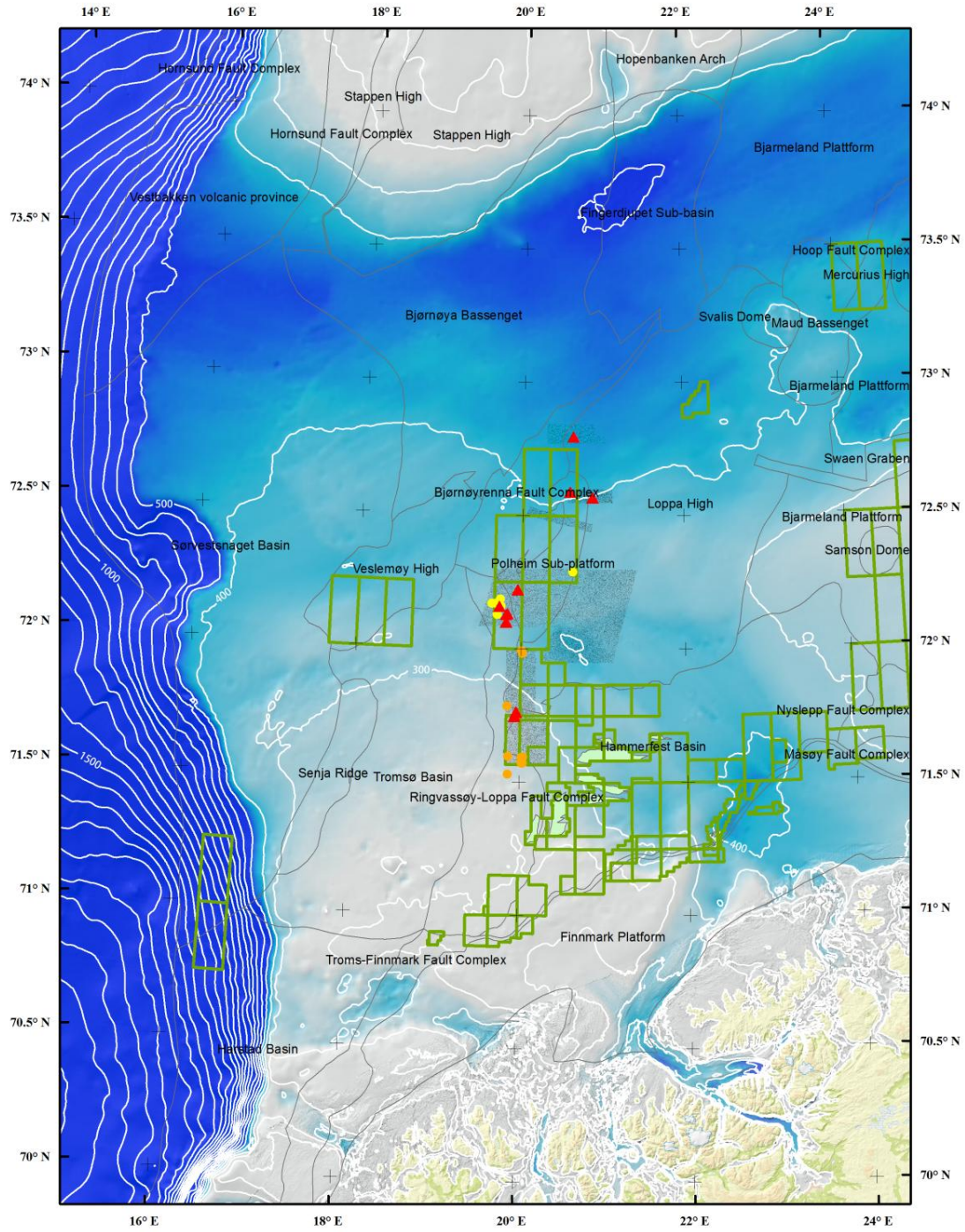
Study area – Lopphøgda, Barents Sea

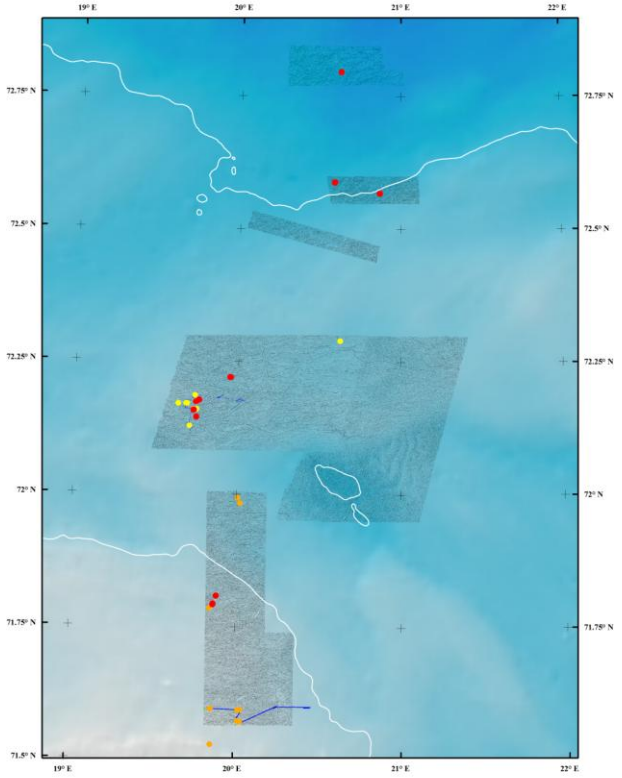


Blocks

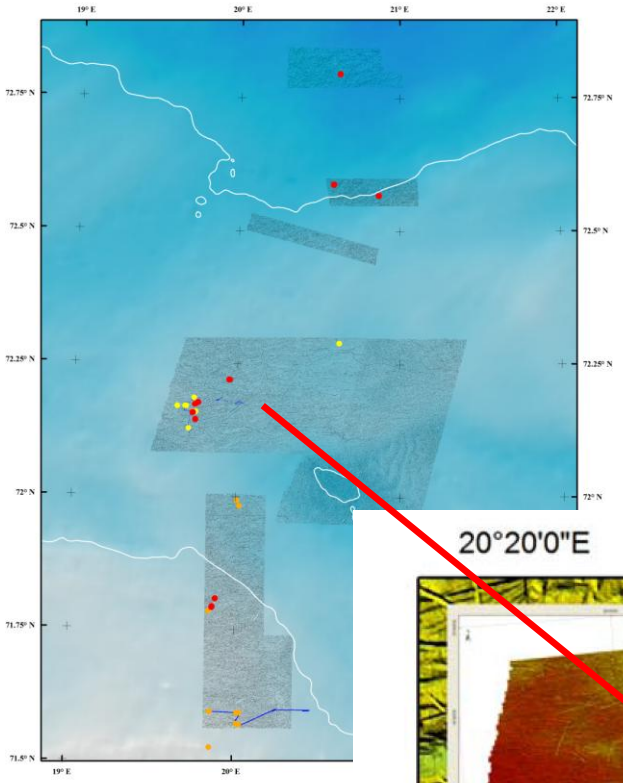
Gas seepages

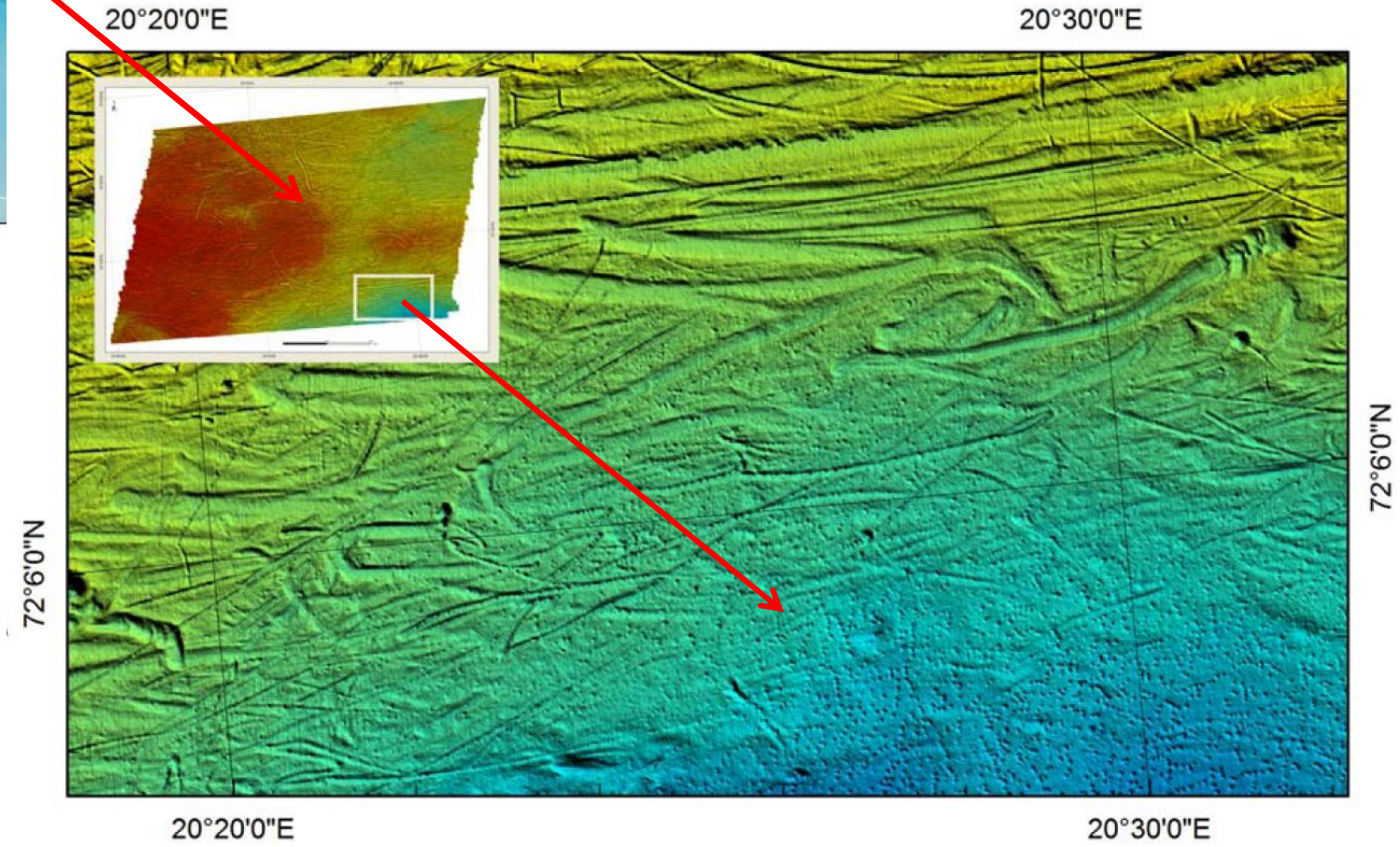
Multibeam areas



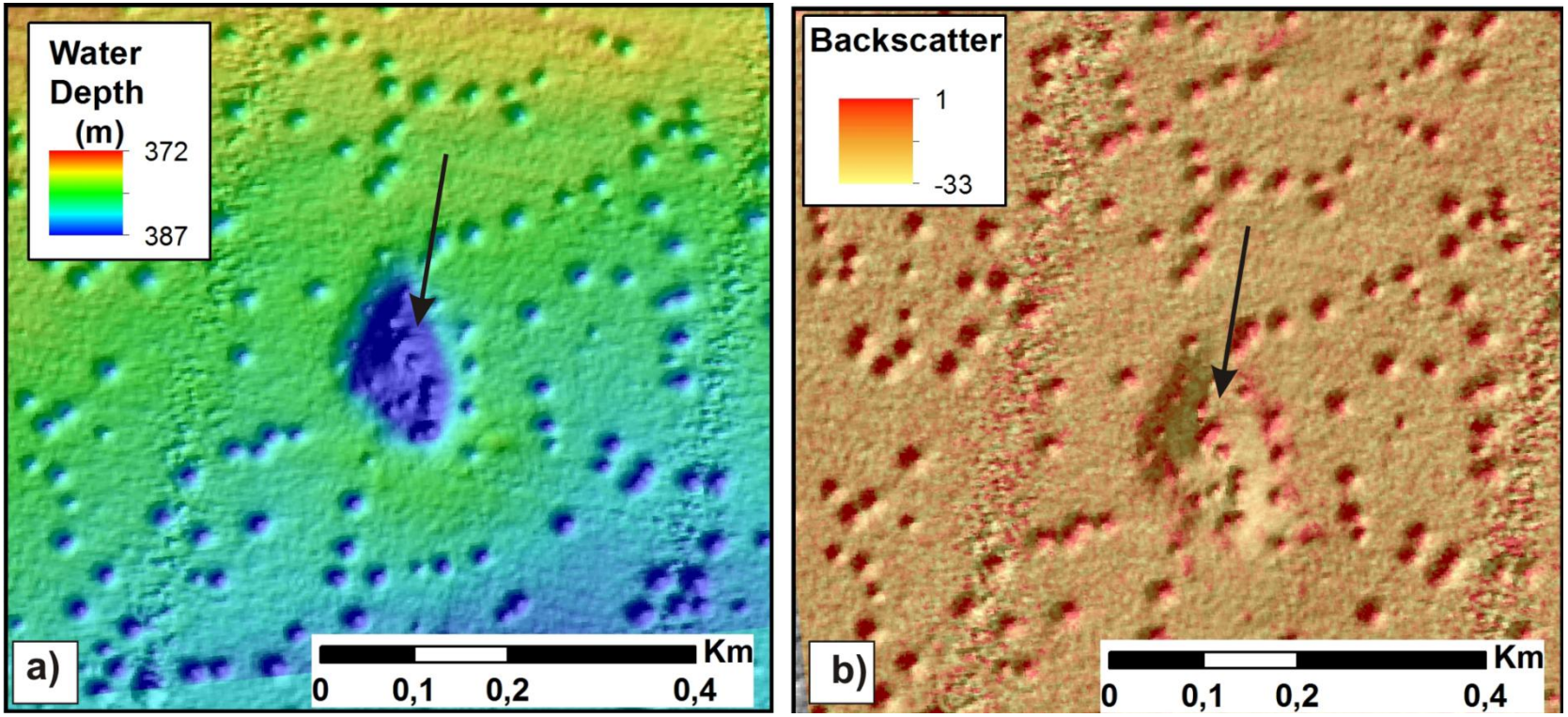


Gas seepages
Pockmark areas



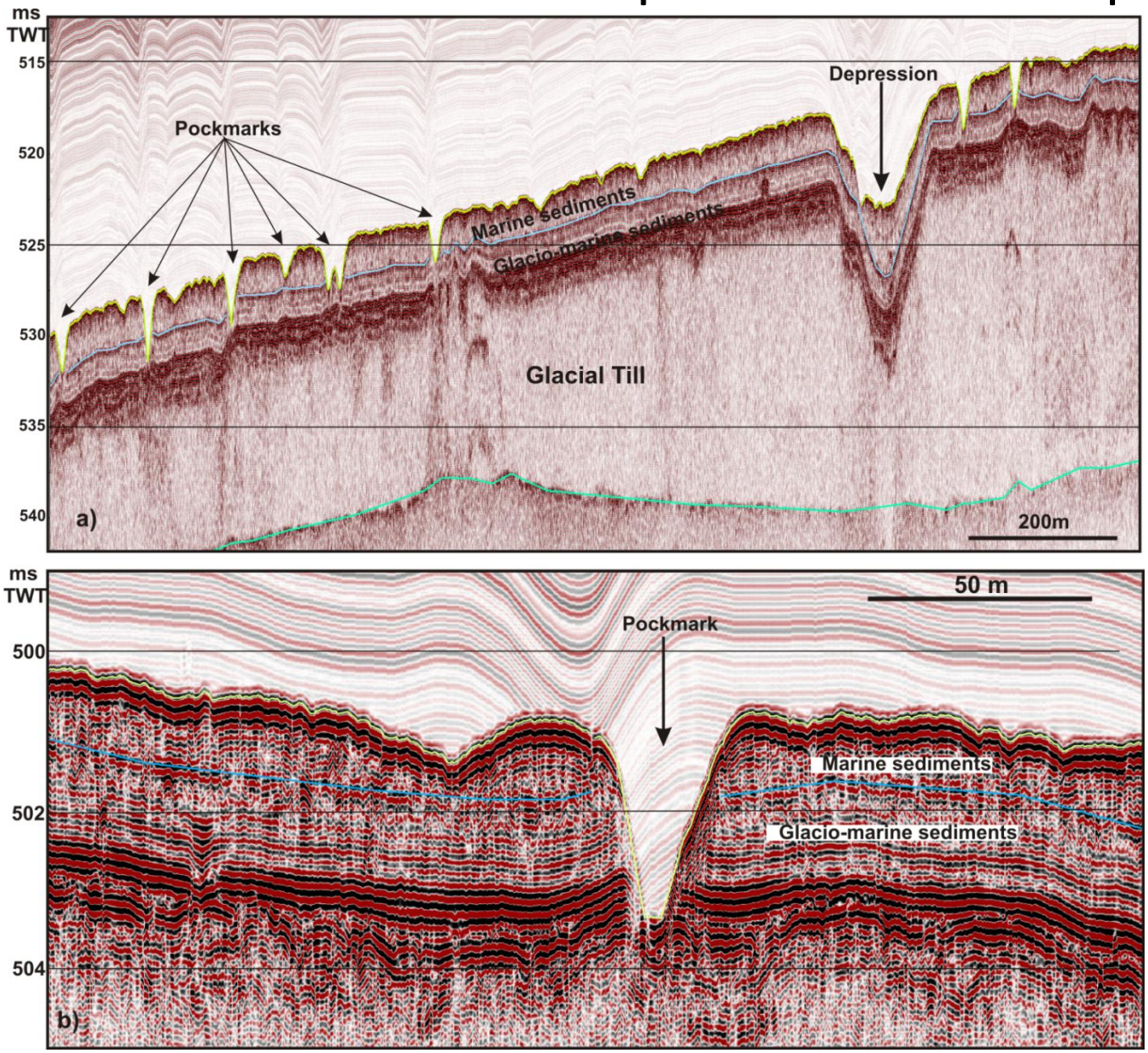


Pockmarks – common expression of fluid flow



Bathymetry and backscatter signature of pockmarks and depressions

Hi-res seismic of pockmarks and depressions

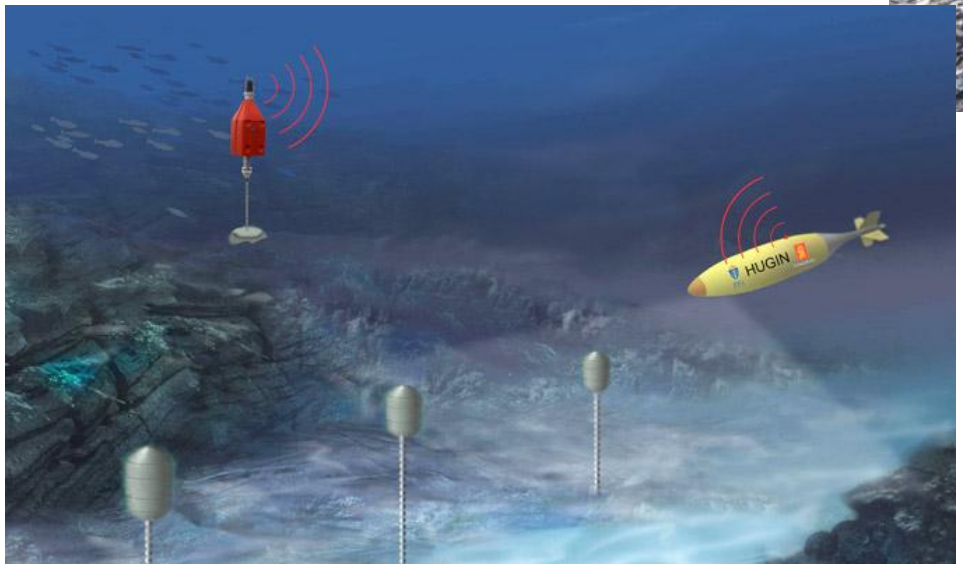


Hullborne TOPAS – H.U.Sverdrup II

Internal structure of pockmarks and depressions

Sub-bottom profiler – HUGIN HUSII AUV

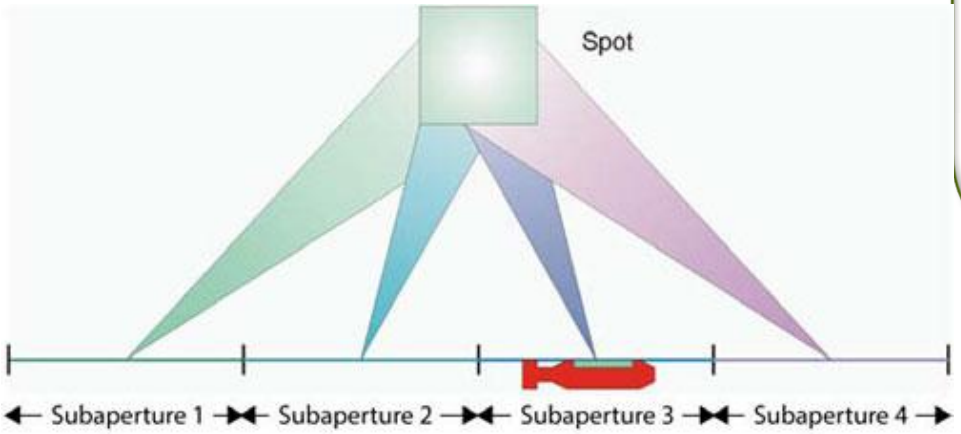
FFI Hugin HUS AUV - Autonomous Underwater Vehicle



AUVs - platform for a range of instruments

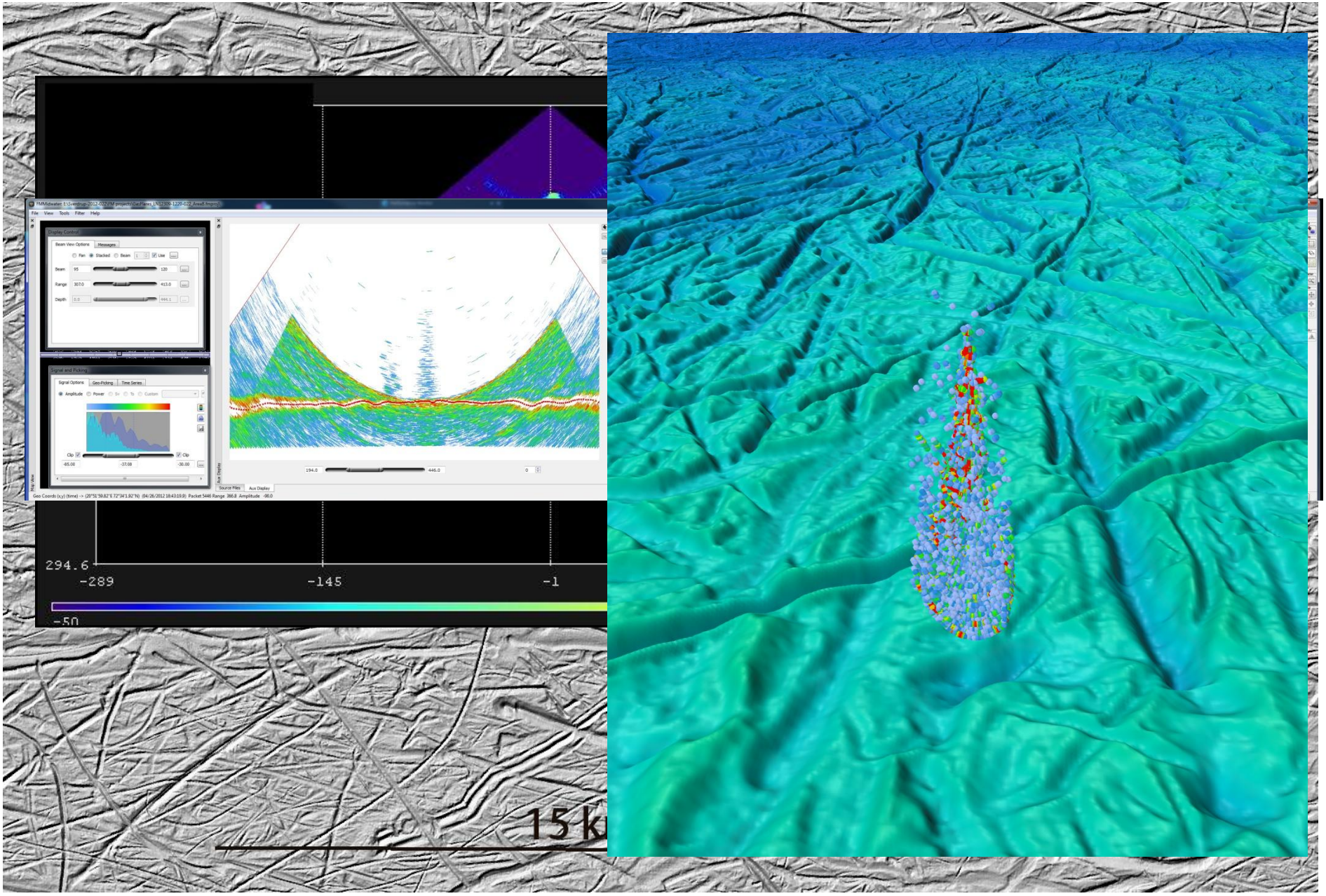
- Multibeam echosounder
- Traditional sidescan sonar
- **Synthetic Aperture Sonar**
- Photo system – e.g. Tfish b&w photos
- Methane sniffer
- Other environmental sensors, such as Temperature, Salinity, Turbidity

Synthetic Aperture Sonar- HiSAS

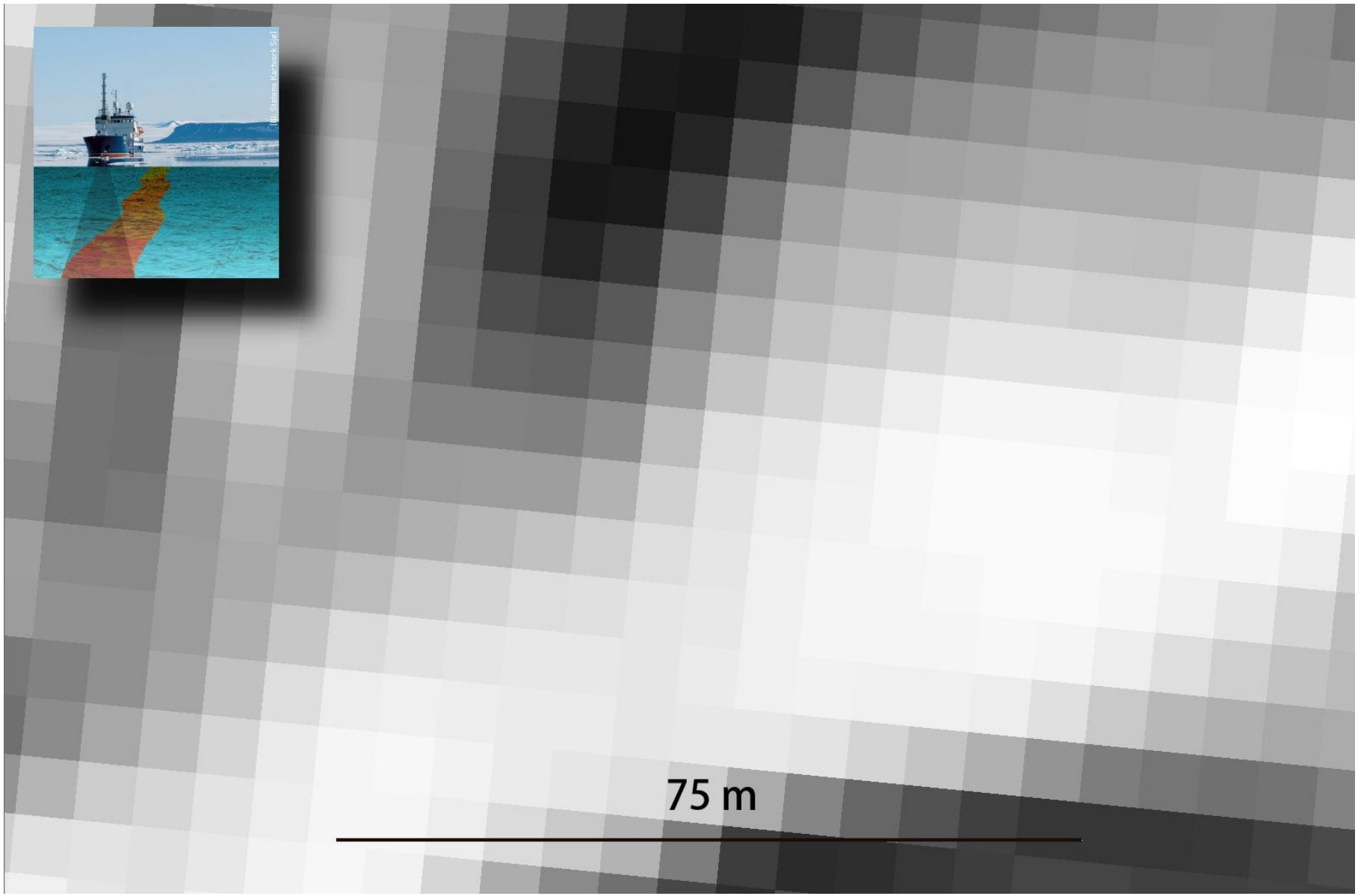


- Range-independent resolution
- 5x5 cm – 2x180 m swath
- Max resolution – 2x2 cm
- 60 Gb/hr
- Coverage 2 km2/hr
- Bathymetry

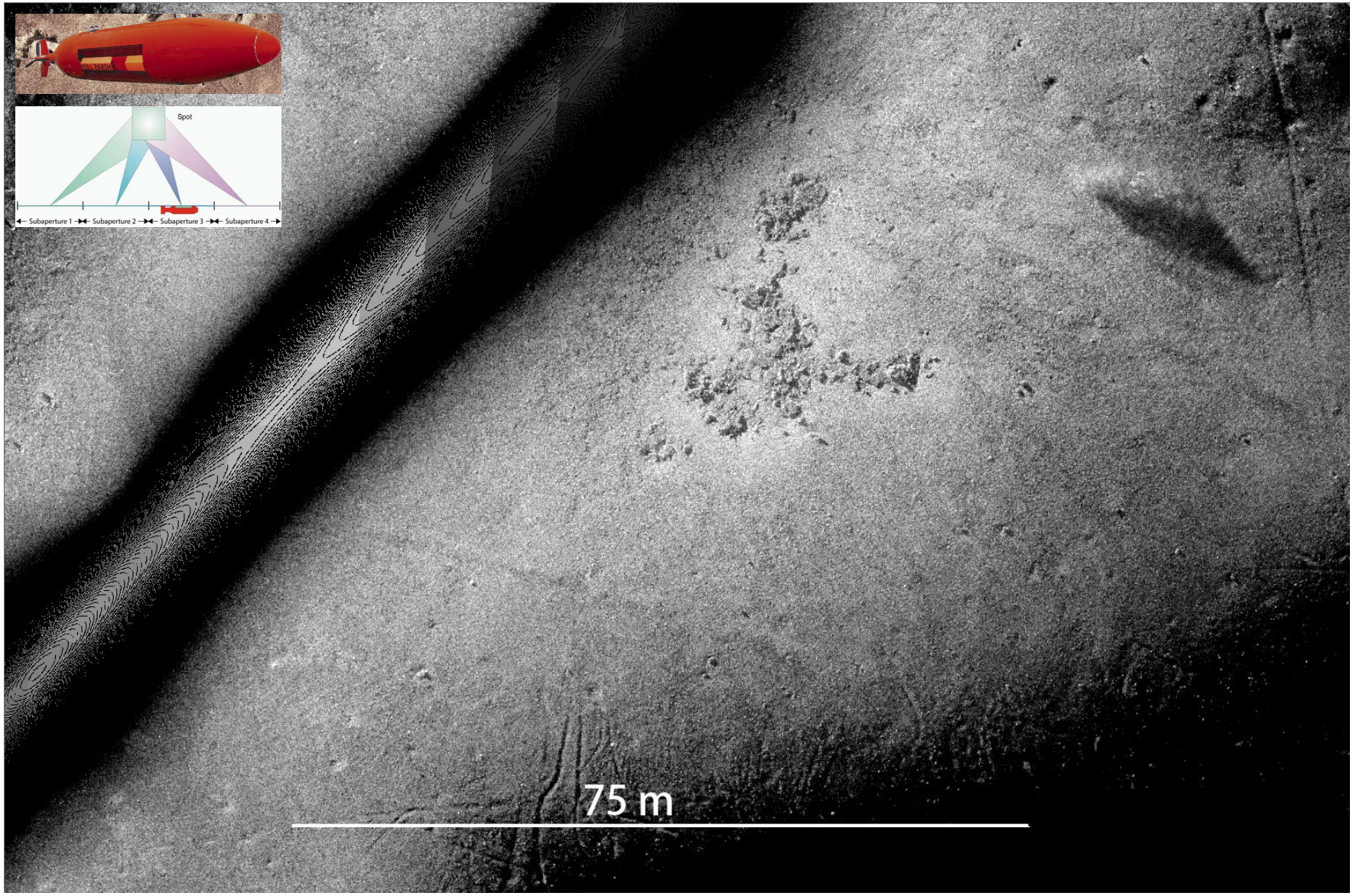
Step 1 – multibeam bathymetry incl. water column data (WCD)



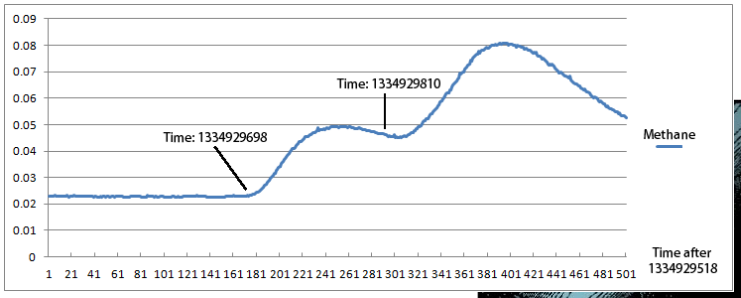
Step 2 – AUV and SAS

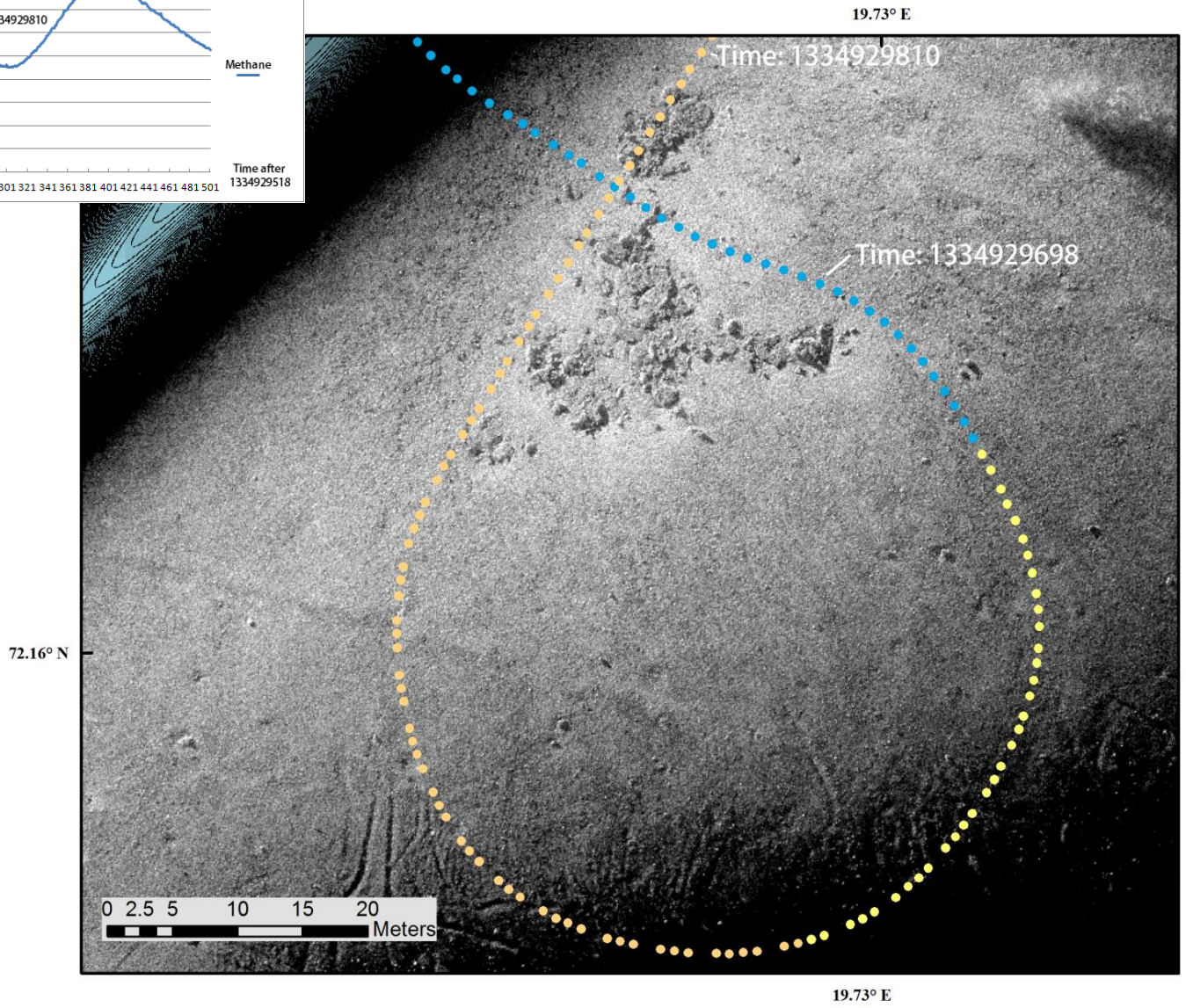


Step 2 – AUV and SAS

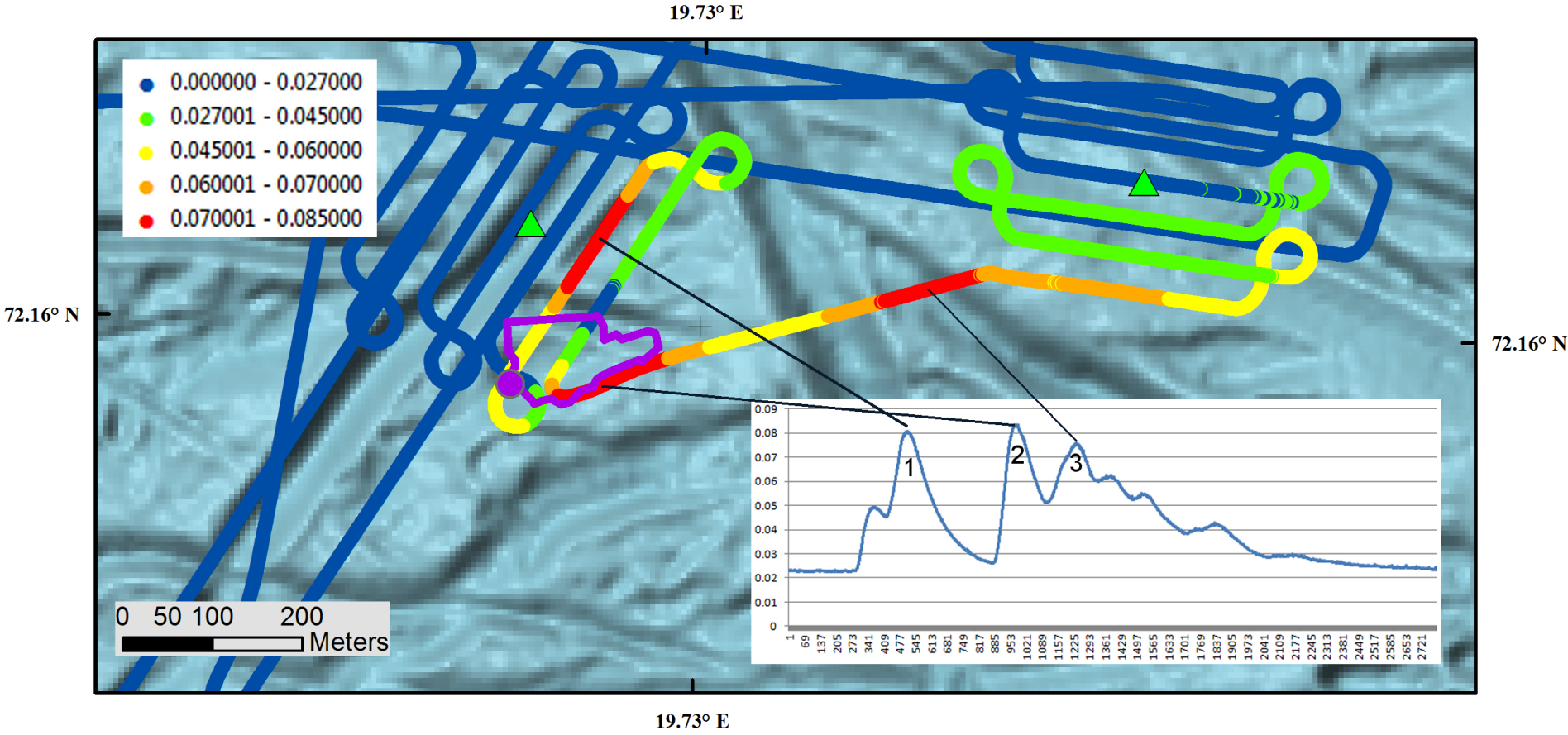


Methane sensor on AUV



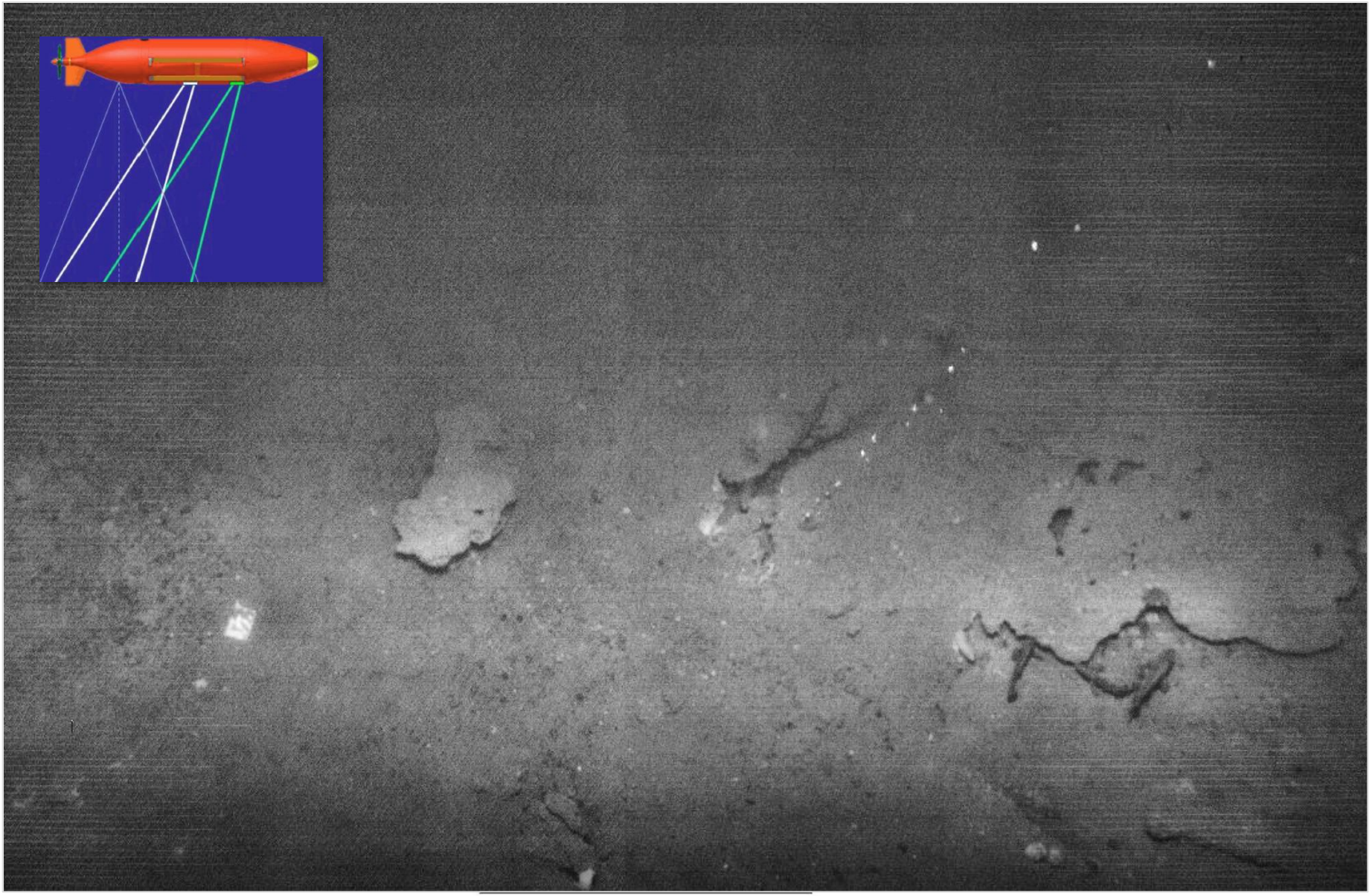


AUV track lines with colour coded methane levels

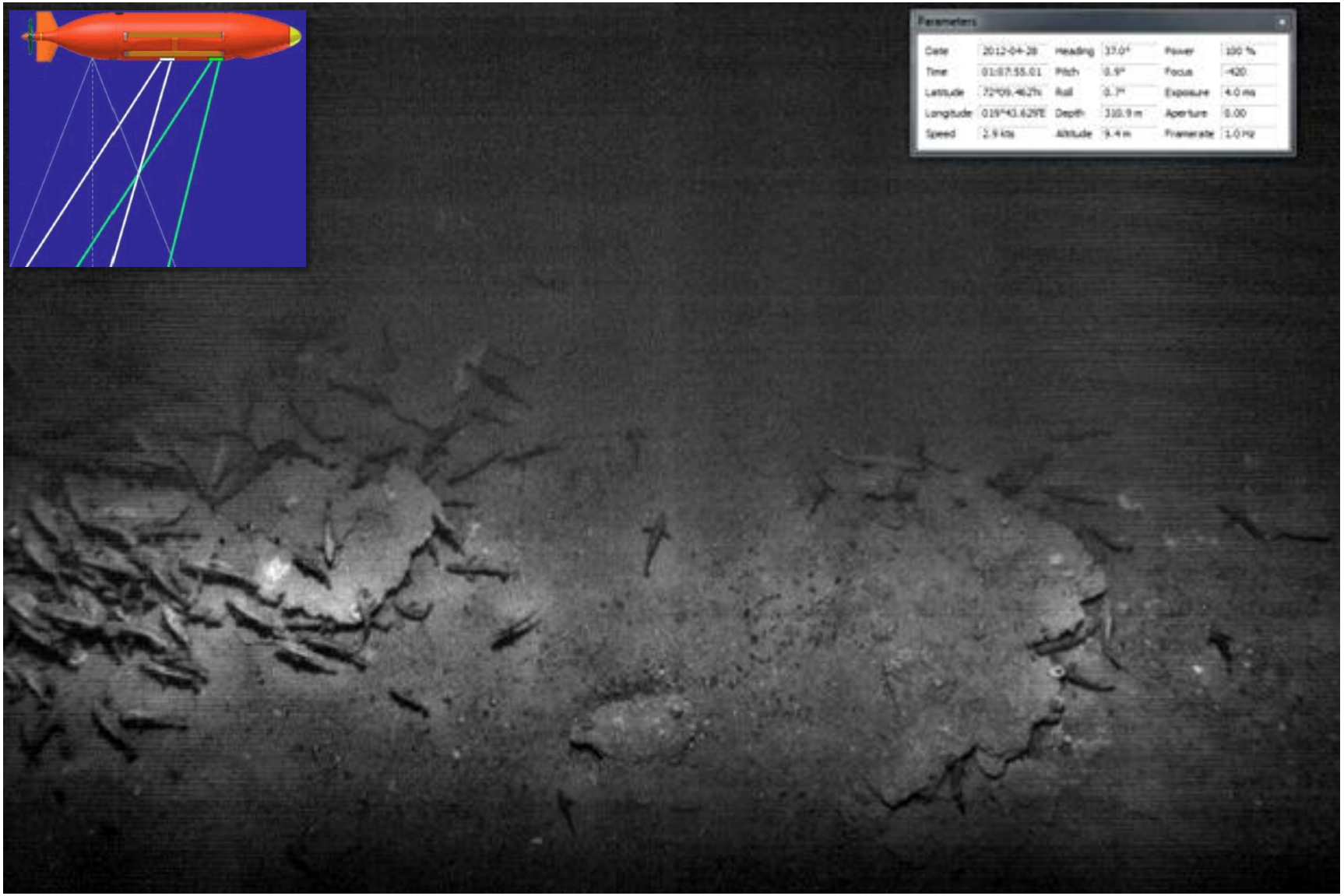


Initial response is rapid (seconds), but peak levels may take minutes to reach (T90)

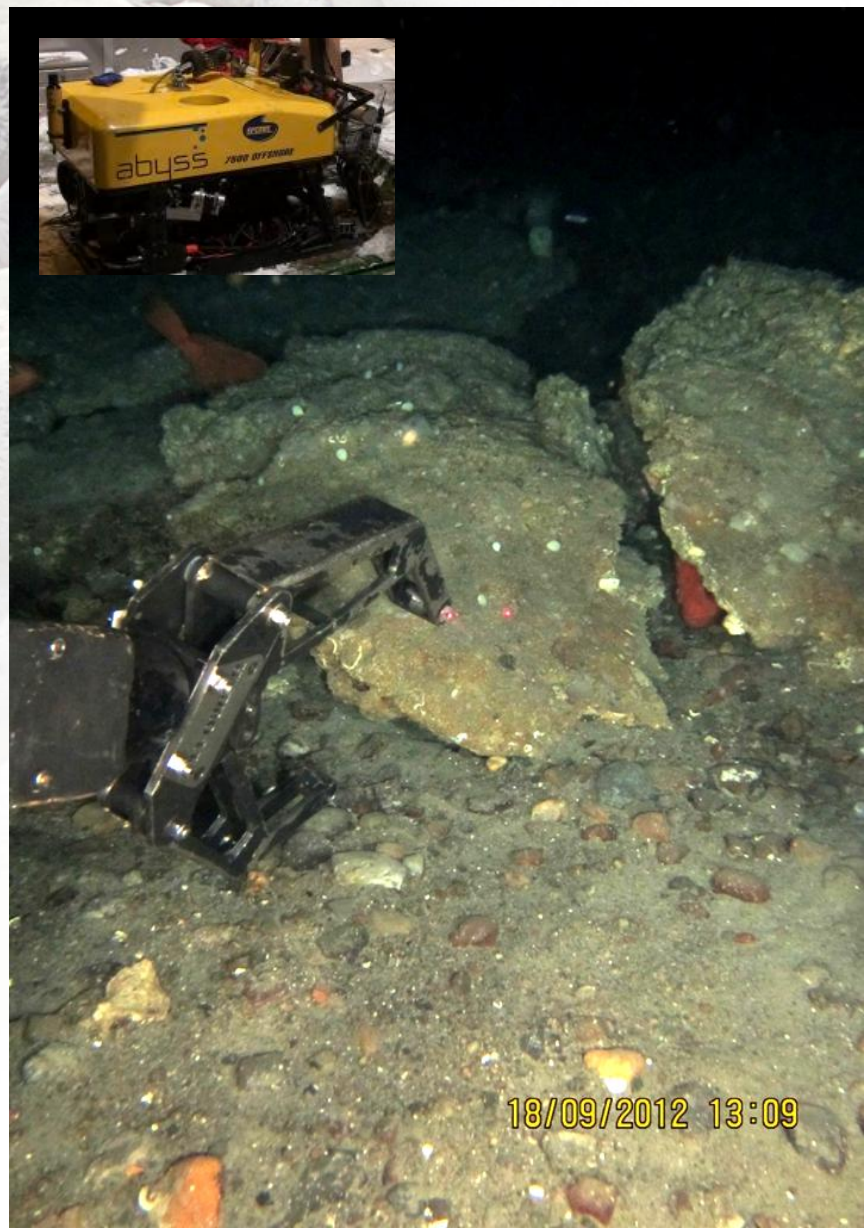
Step 3 – Tfish images, showing the first direct documentation of gas bubbles in the Barents Sea (width 7 m)



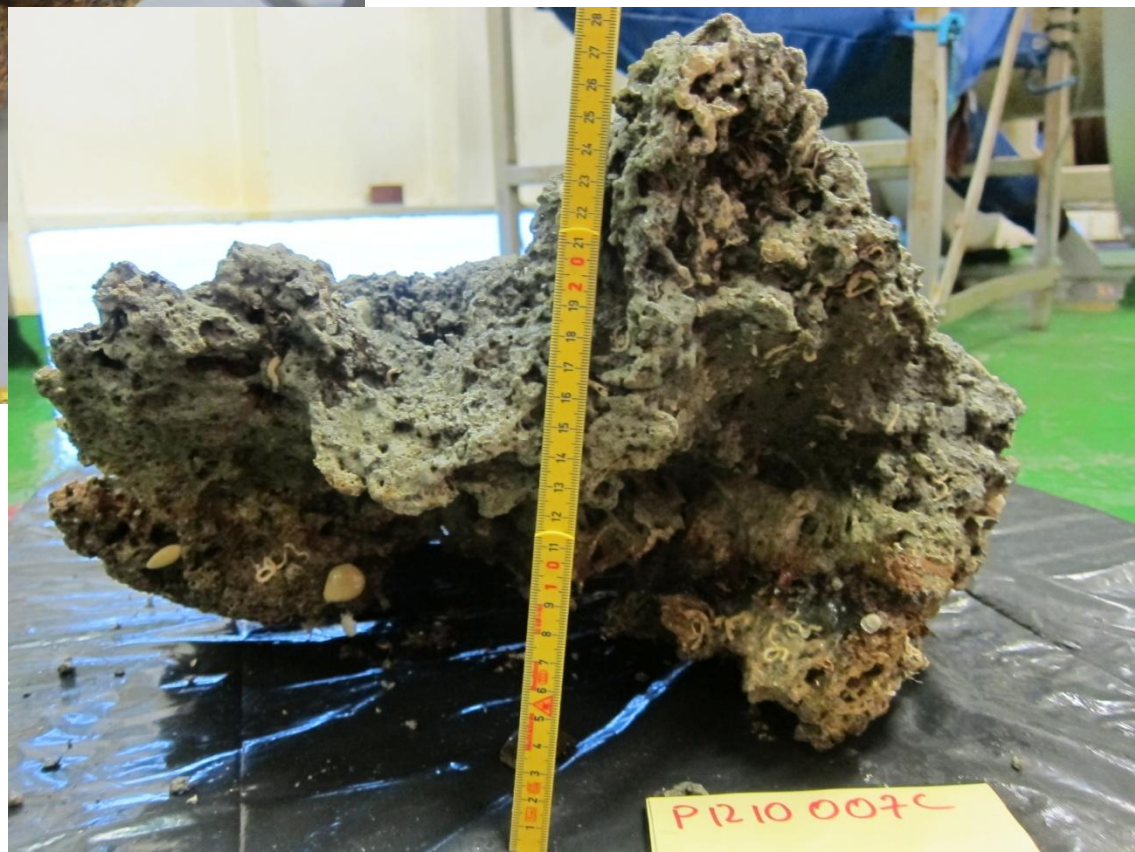
Who said fish do not care about geology?



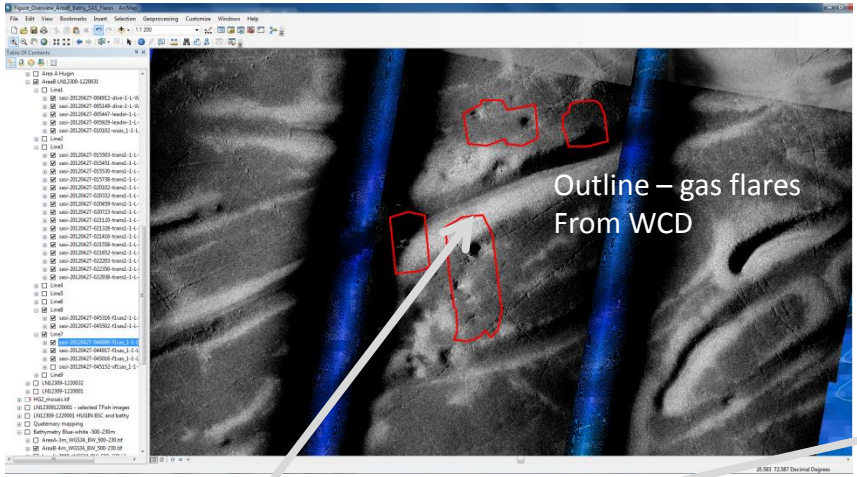
Step 4 – ROV with video and sampling gear

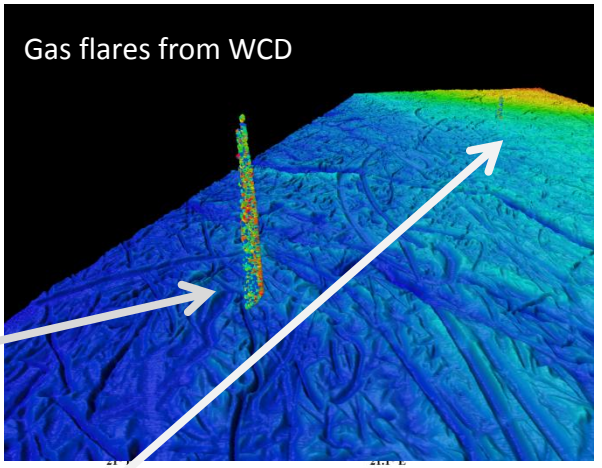


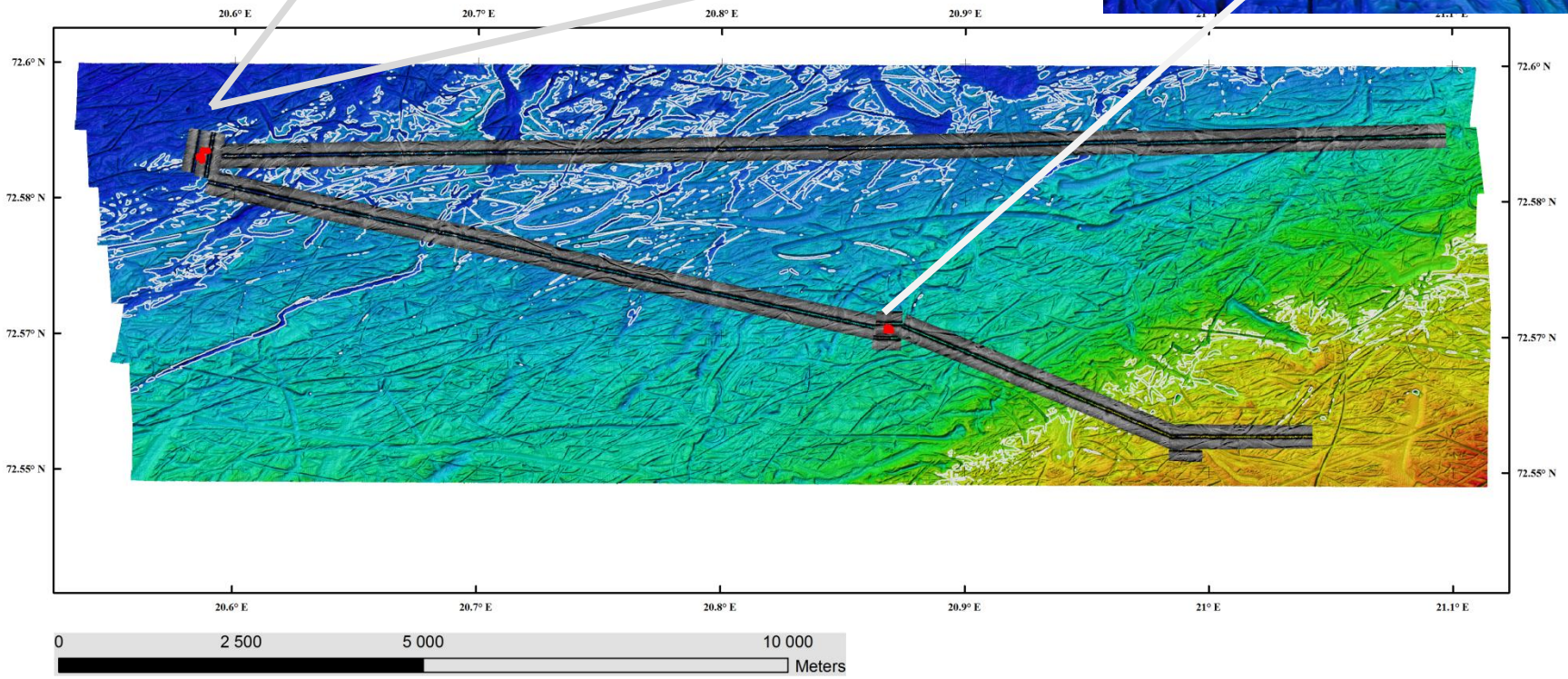
Carbonate crust samples – on deck



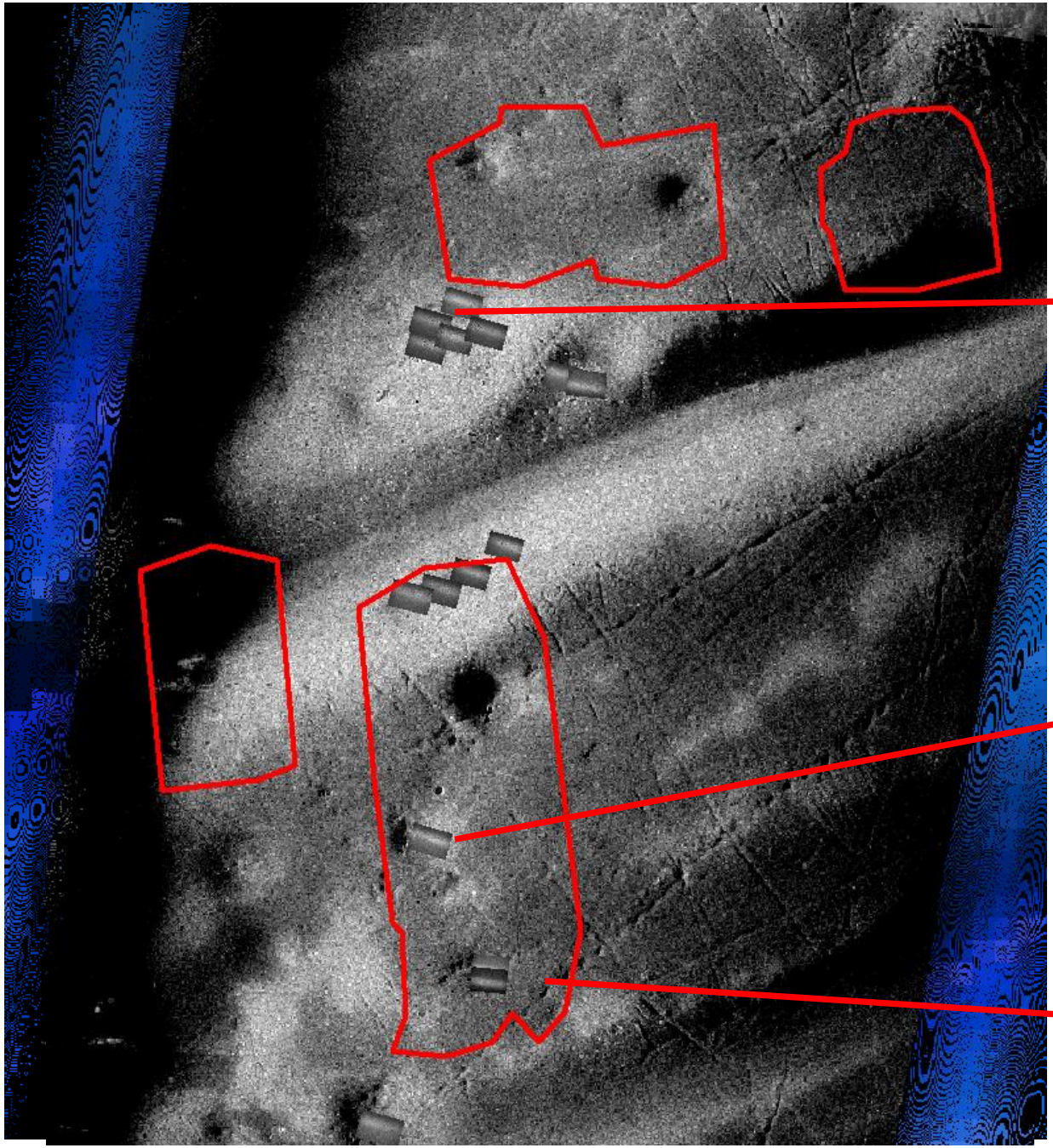
Test – separate area – linking gas flares to carbonate crusts again?

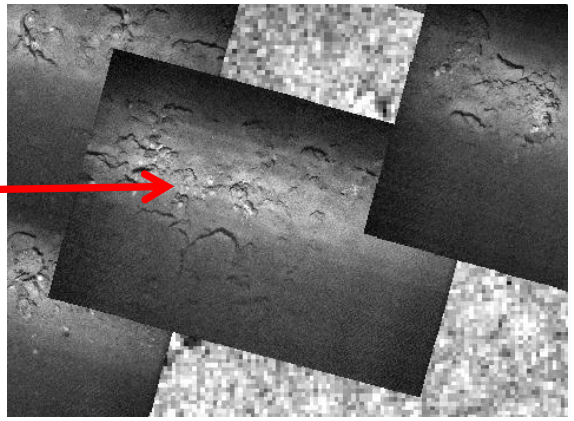


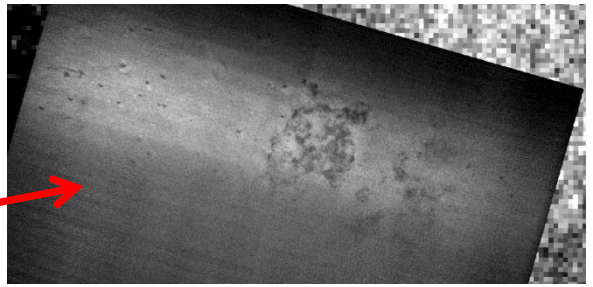


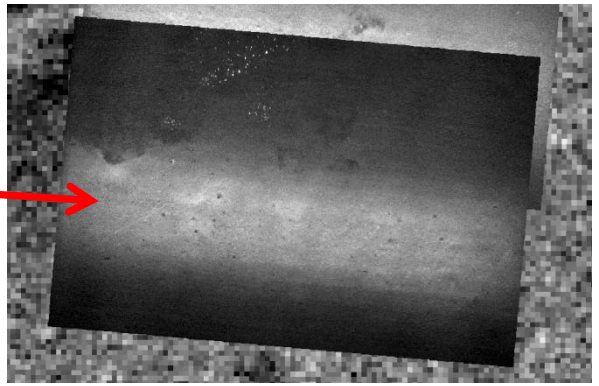


HiSAS imagery, with Tfish photo overlay









Conclusions and experiences

- Multi-scale approach: Hullborne MBE – AUV with HiSAS and Tfish - ROV
- Water column data indicates gas flares (beware of fish shoals!)
- Note – gas flares are episodic events – on and off
- Hullborne MBE data give too low resolution for identifying seep-related structures
- HiSAS may, or may not, identify carbonate crust structures
- Visual documentation is necessary to verify carbonate crust structures, and related phenomena like depressions with algal mats
- Sampling carbonate crusts with grabs and box corers is challenging – ROV…

Combination of hullborne hi-res acoustic tools with AUVs fitted with dedicated sensors provides excellent opportunities to increase the scientific understanding of shallow geological processes, and for more applied investigations related to natural or anthropogenic gas seepages

ROV cruise in the Barents Sea September 2012

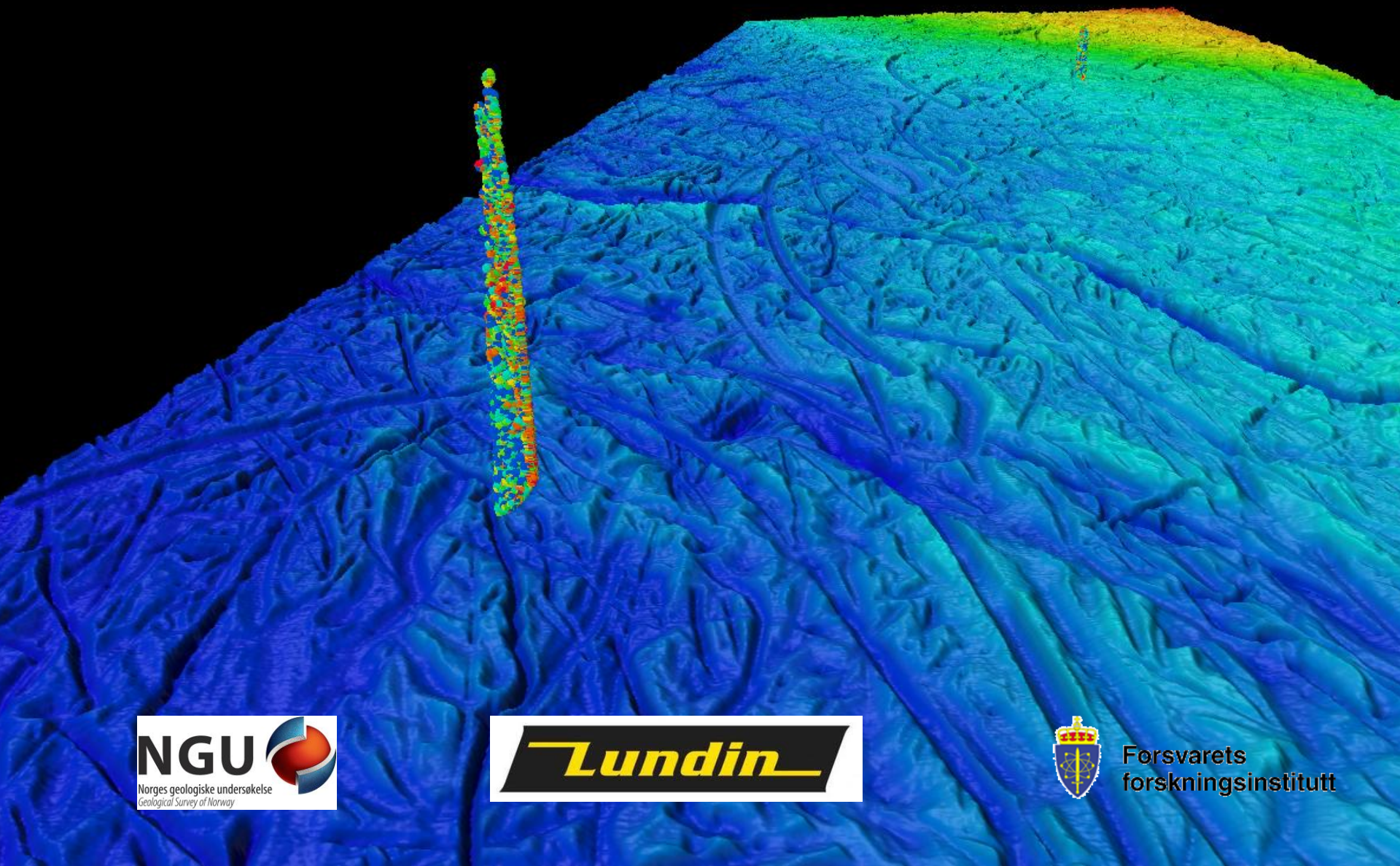
NGU/Lundin

Video compilation
by Simone Sauer

Lundin

NGU

Thanks for the attention!



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