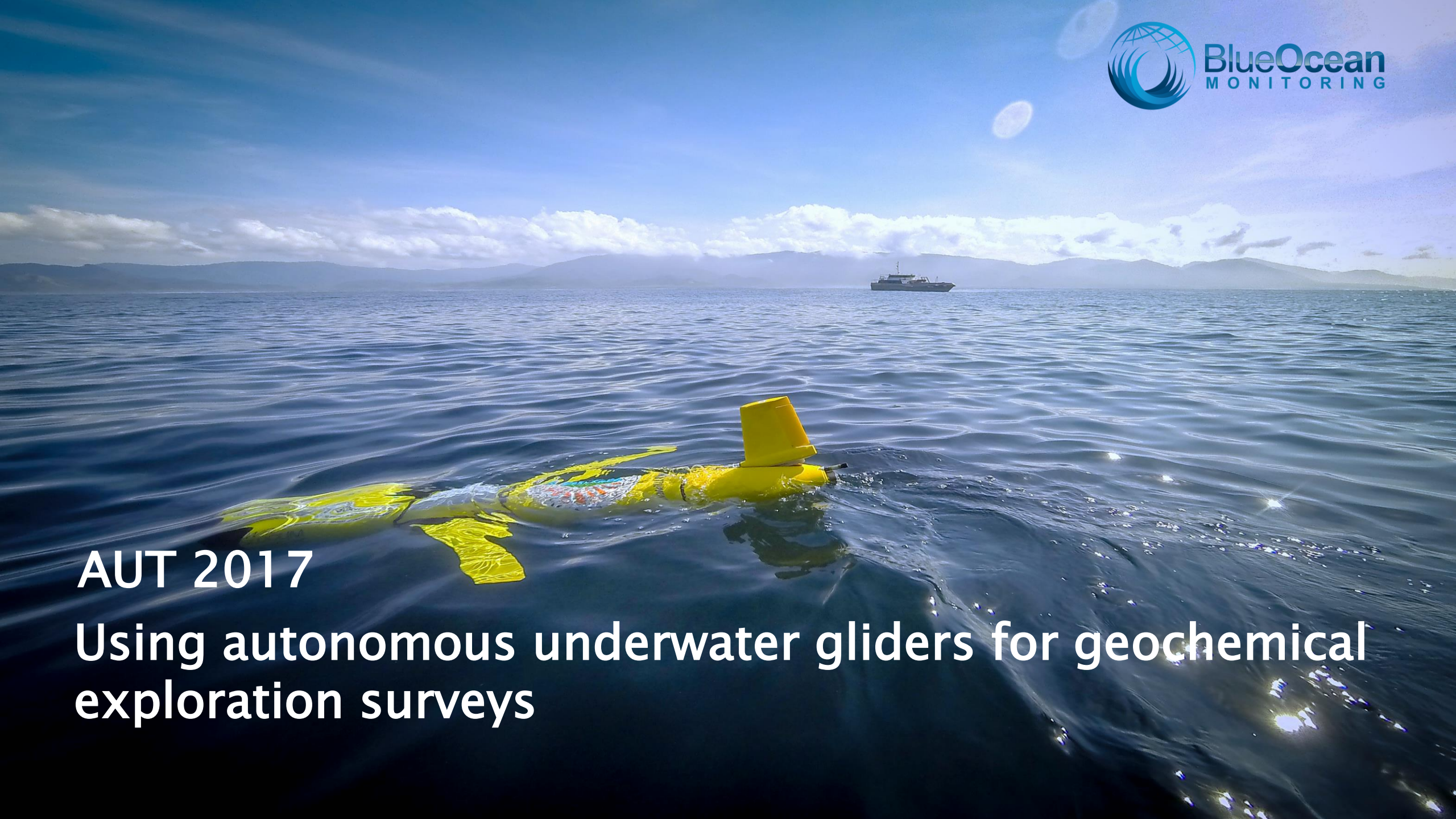


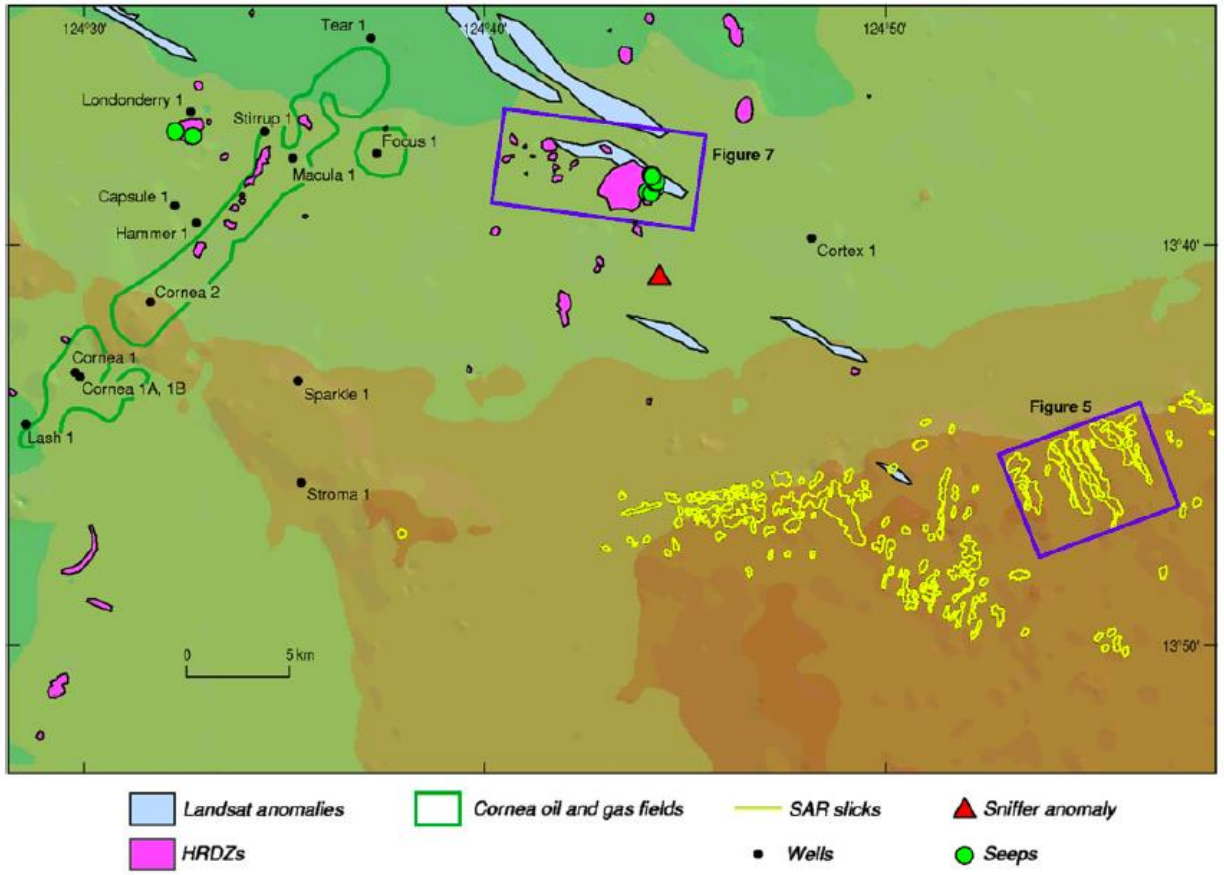
AUT 2017

Using autonomous underwater gliders for geochemical exploration surveys

GEOCHEMICAL INVESTIGATIONS

Explore smarter.

- Cost effectively map the presence and distribution of oil and gas seepage to:
  - Provide evidence of active hydrocarbon system
  - Focus exploration surveys (reduce over-shoot)
  - Investigate geophysical anomalies



Geoscience Australia – Rollet et al, 2006.

SURFACE

Remote sensing technologies can be cost effective and useful for early stages of exploration but false positives are an issue.

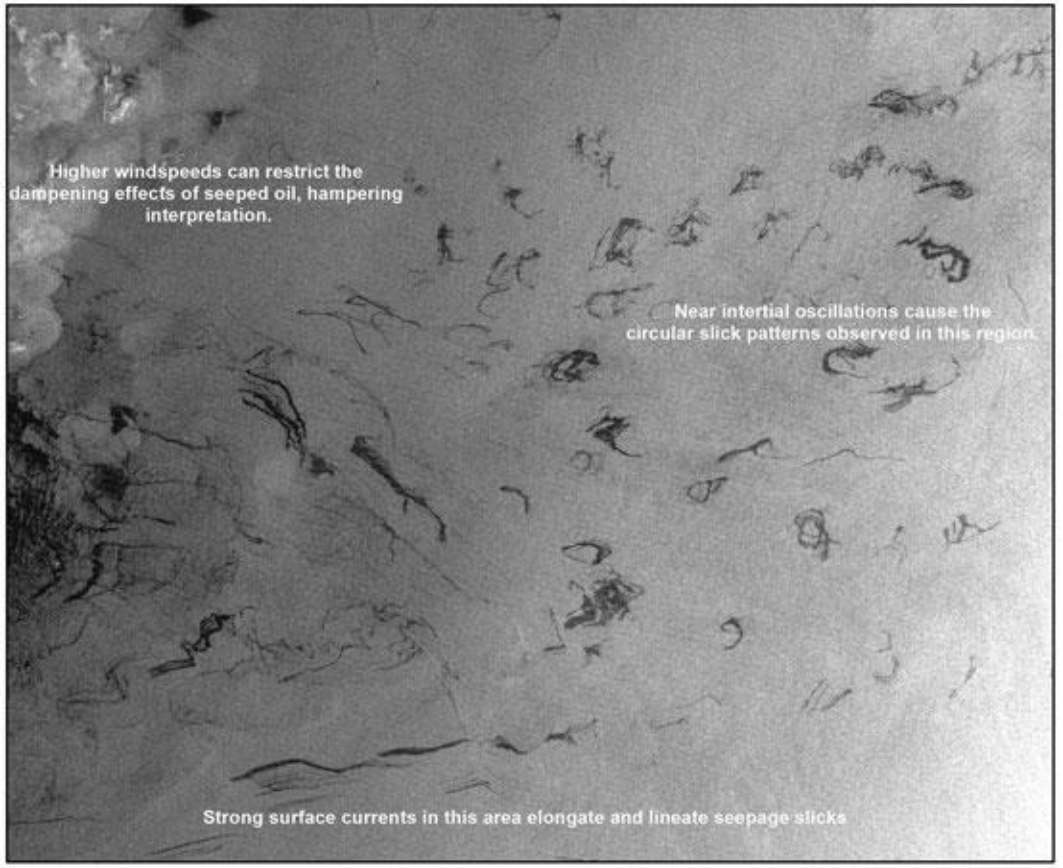
Synthetic Aperture Radar (SAR)
Airborne Laser Fluorescence (ALF)

Advantages

- Great spatial coverage
- Cost effective

Disadvantages

- False positives (biological, physical ocean processes)
- Requires ground truthing
- Cannot detect methane
- Provides poor understanding of were the slick emanated from (influences of ocean processes)
- Coverage issues



CGG NPA Satellite Mapping

WATER COLUMN

Uncertainty in the results of acoustic surveys can mean they are often done in conjunction with other surveys.

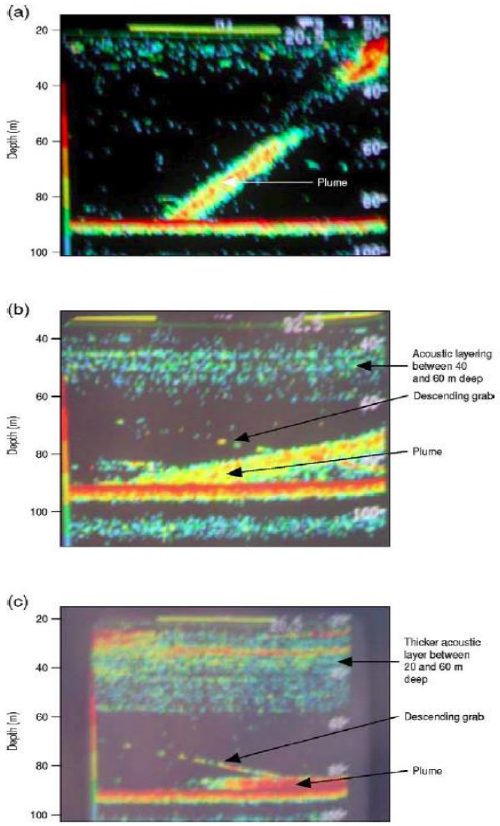
Mulit-beam echo sounder
Side scan sonar
Sniffers – spectroscopy, fluorometers

Advantages

- More reliable than surface measurements
- 3D visualisation
- Provide more geological and geophysical insights

Disadvantages

- Costs (vessels)
- False positives (biological material)
- Intensity of seeps needs to be strong
- HSE implications of vessel operations
- No thermogenic / biogenic discrimination



Methane plume on MBES
Geoscience Australia – Rollet et al, 2006.

SUBSURFACE

Coring provides thermogenic / biogenic discrimination but at significant cost.

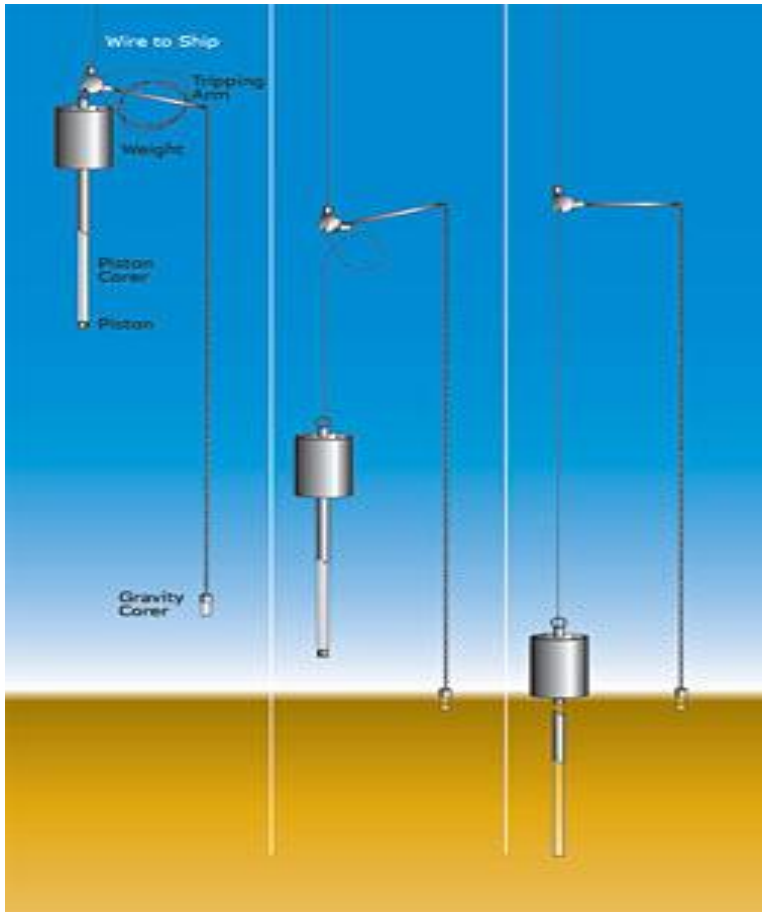
Geotech sampling (coring)
Sub bottom profiling (SBP)

Advantages

- Geotech: Hydrocarbon fingerprinting (GCMS)
- SBP: Good signal to noise ratio. Attribute analysis can identify acoustic anomalies and HRDZs

Disadvantages

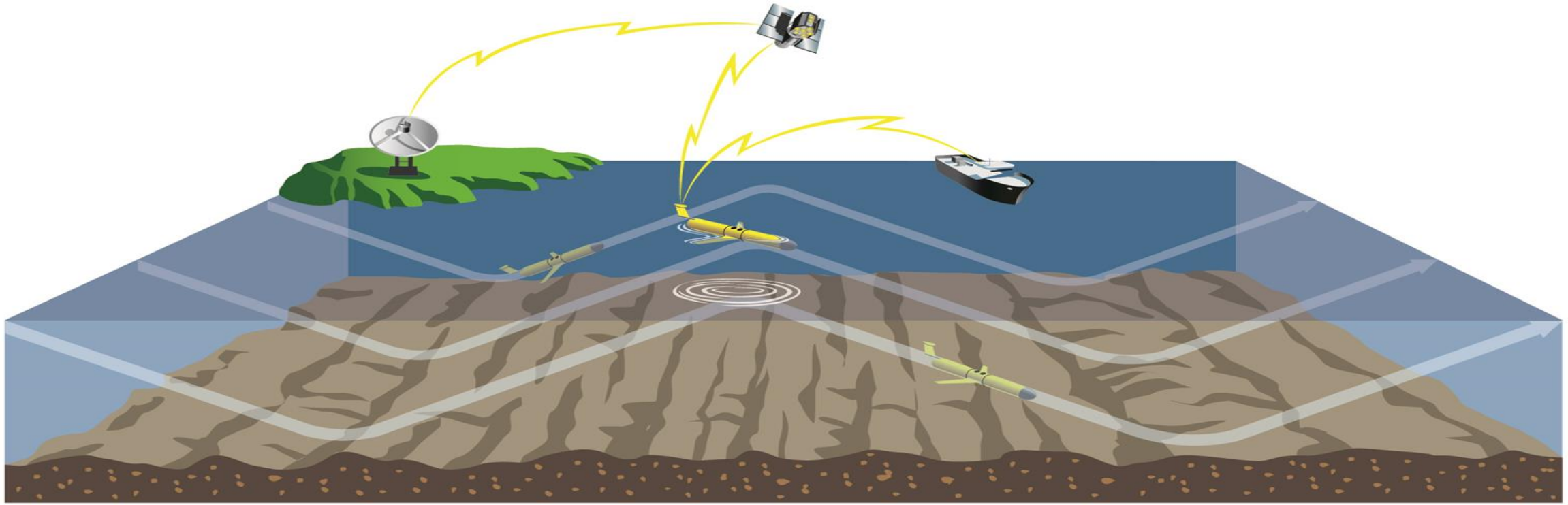
- Very expensive surveys (vessels, core rigs, refrigeration, transportation of cores and analysis)
- Every meter matters! Core needs to be taken from within paleochannel so other surveys (MBES) must be done in advance
- Up to 4-6 month delay on results
- HSE implications of vessel operations



Piston core sampler
illustration by Fritz Heide, WHOI

SLOCUM GLIDER OPERATION

Slocum gliders use small changes in buoyancy to move through the water column, this is converted to horizontal motion by wings, resulting in a “saw-tooth” dive profile.



Once on the surface the glider data is transmitted via satellite (RF options to rig/vessel) to our control and data processing centre, from which our clients can remotely access the data.

With 2-way communications, we can interact with the glider and modify the survey as required.

UNDERWATER GLIDERS

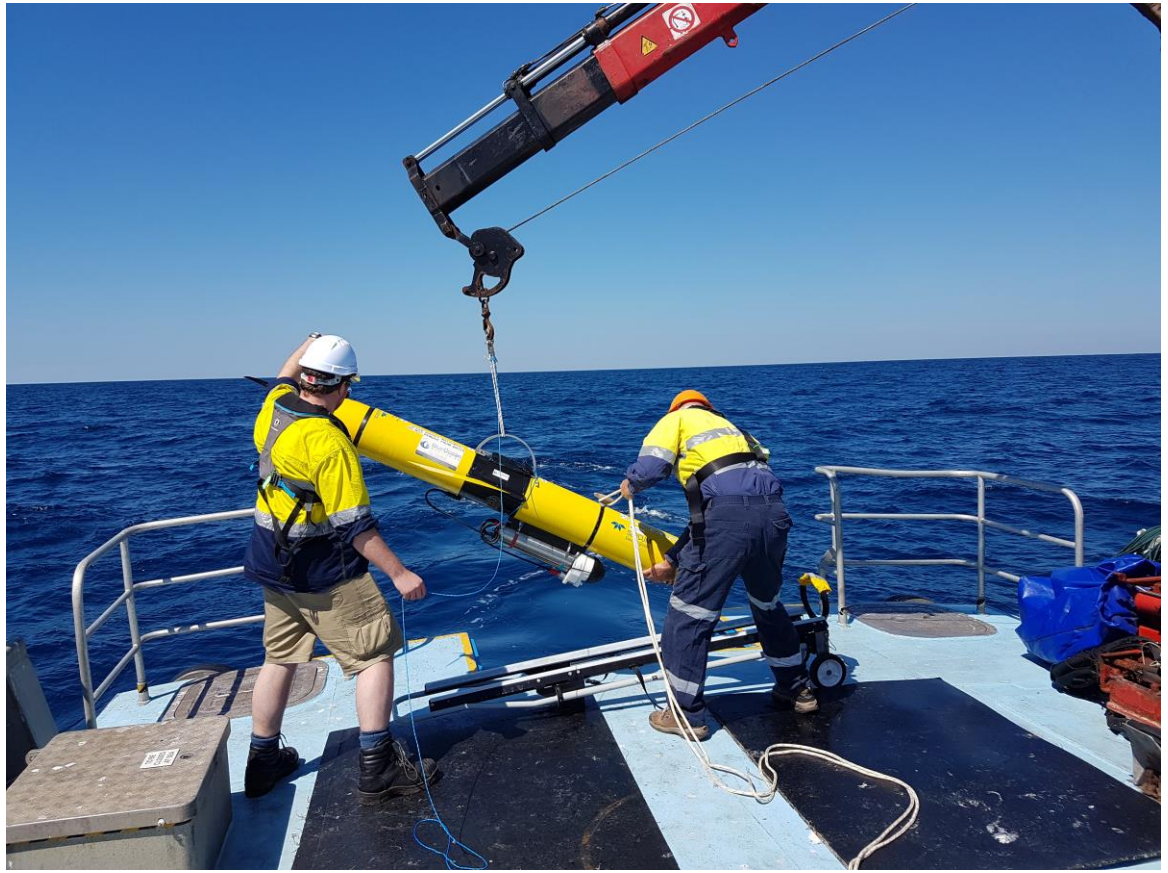
The future of marine geochemical surveys?

Advantages

- Very cost effective
- High quality data:
  - TDLAS - high sensitivity, resolution and speed of measurement
  - Biogenic / thermogenic discrimination with fluorometer
  - Good endurance
- Significantly reduced HSE implications

Disadvantages

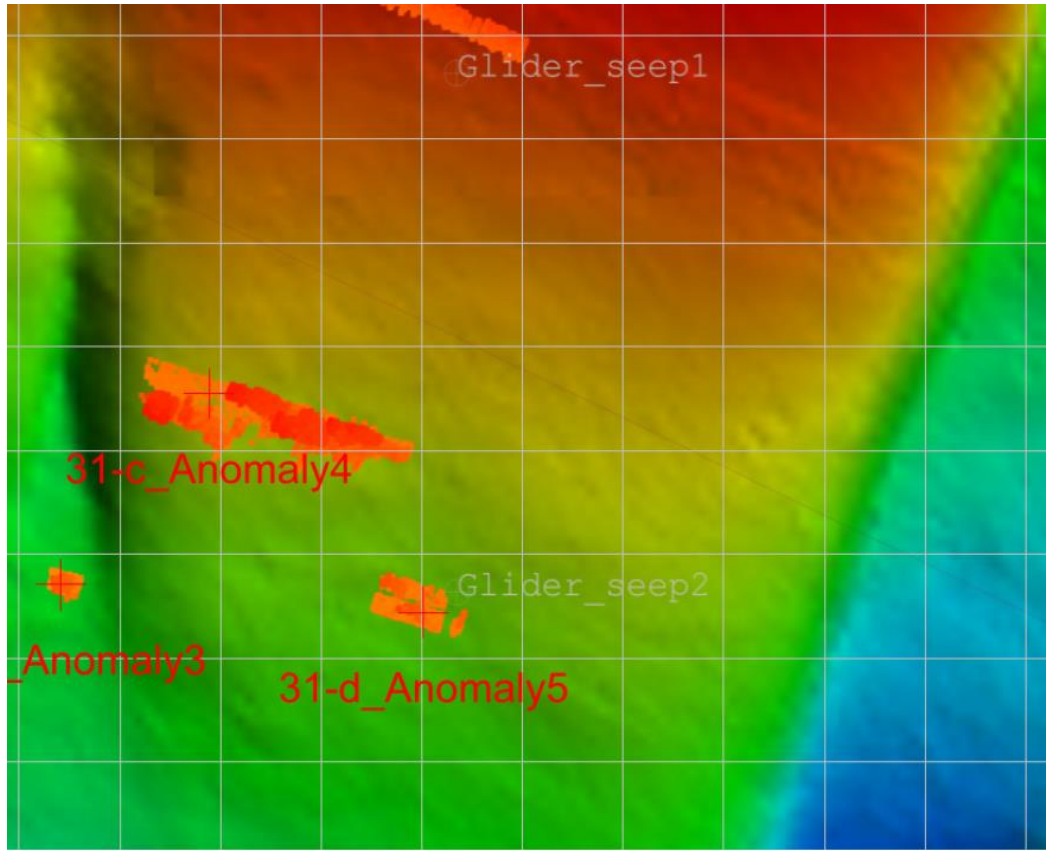
- No hydrocarbon fingerprinting (presence / absence result)
- Swath of survey is limited
- Depth limited to 1,000m (2,500m+ glider will be arriving soon)



GENESIS – PNG DAVARIA SURVEY

Our first glider geochemical survey taught us a lot.

- Multi-client speculative data shoot with survey partners
- Glider was equipped with 2 fluorometers
- Encouraging results but more work needed to be done on instrumentation, piloting and data visualisations



Glider anomalies plotted on MBES
Blue Ocean Monitoring, Gardline Marine Sciences, Searcher Seismic

YAMPI SHELF

Compare glider data against the 'gold standard'.

- A world first - the integration of the state of the art laser methane sensor on an ocean glider
- Evidence that glider is capable of detecting methane and crude oil from natural seeps
- Adaptive management of the glider

YAMPI SHELF

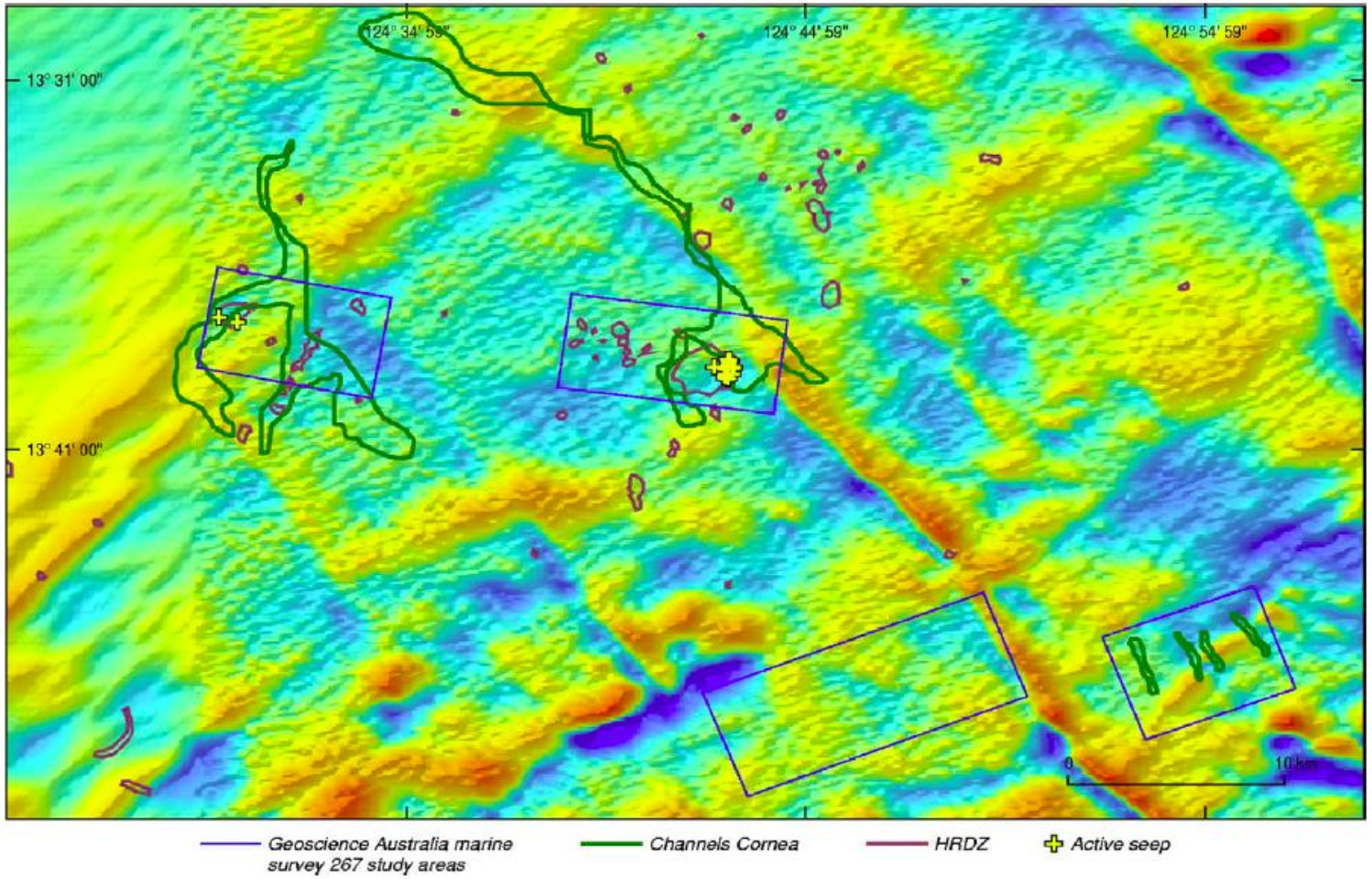


Fig. 11. Aeromagnetic anomaly grid of the first vertical derivative reduced to the pole shows magnetic lineations over the study areas. Lower resolution data are on the western side of the map. Active seepage and related features (pockmarks, clusters of hard blocks and hard-grounds) are preferentially located in areas where the NW trending positive magnetic anomalies are off-set and cross-cut by the conjugate NE trending magnetic anomalies.

Geoscience Australia – Rollet et al, 2006.

YAMPI SHELF

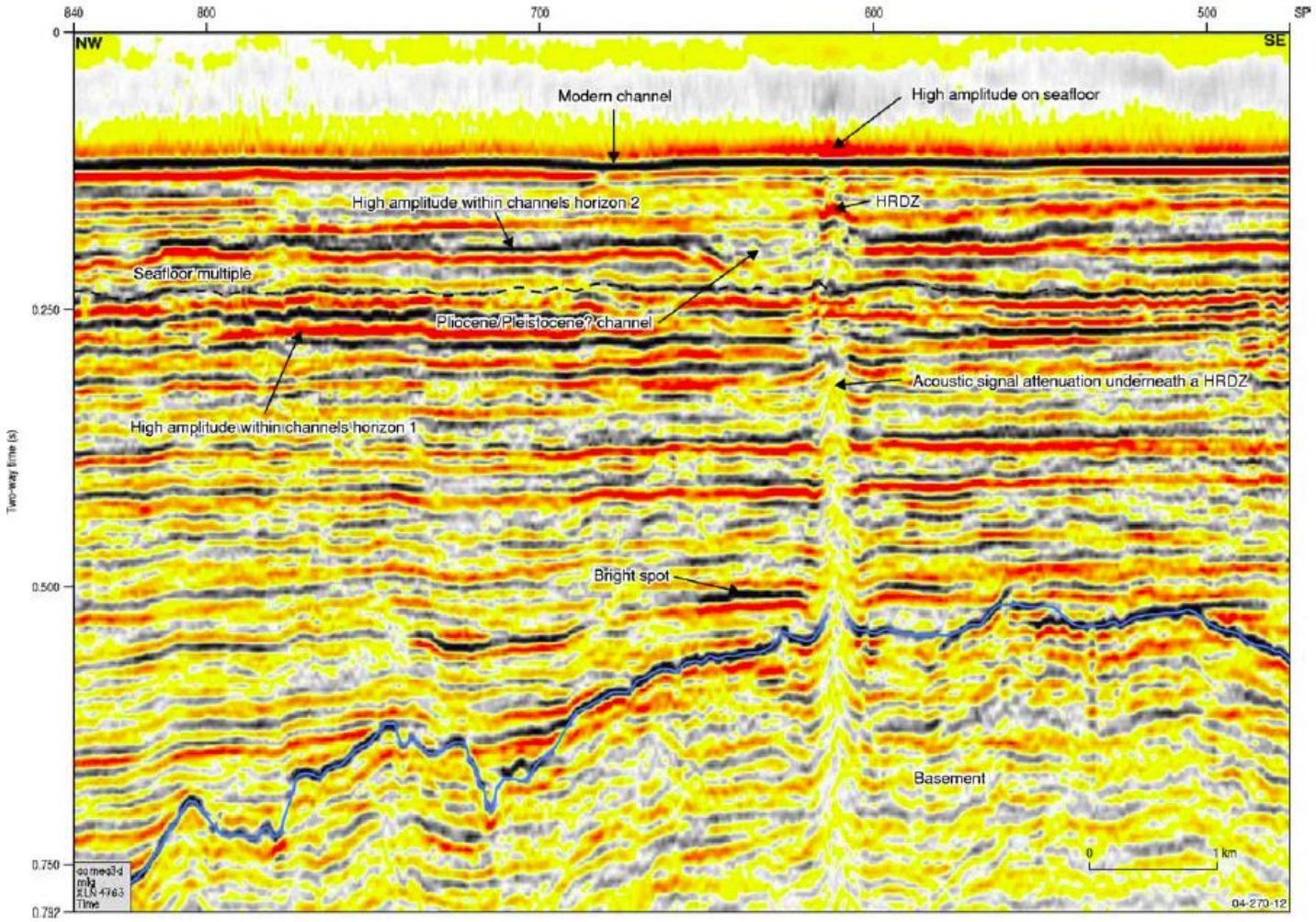


Fig. 12. 3D seismic section showing the development of a palaeo-channel (Plio-Pleistocene?) on the edge of a HRDZ in Cornea area 2. The high amplitude on the seafloor causes acoustic signal attenuation underneath and is located directly above a basement high. Micro-fracturing is also observed from the top of the basement and into the above sedimentary layers.

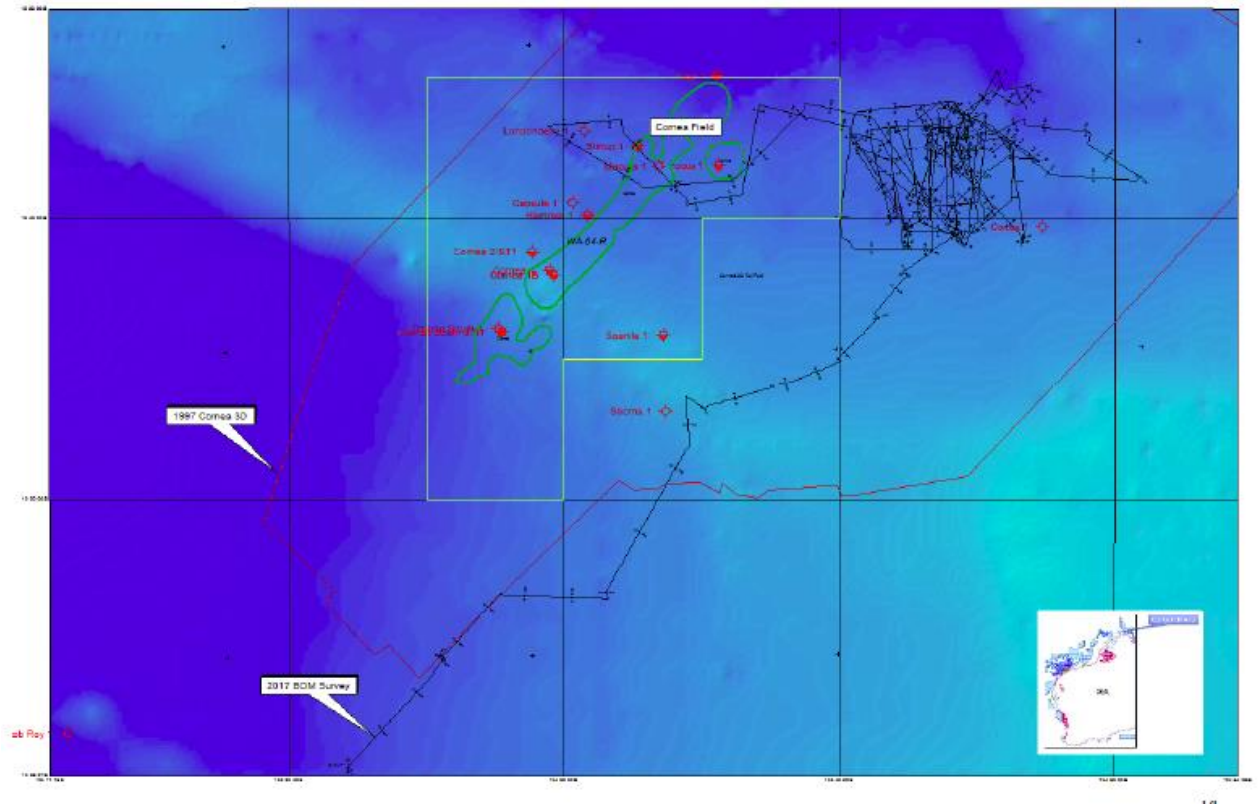
Geoscience Australia – Rollet et al, 2006.

METHODOLOGY

Near real time data allows adaptive management of the glider to investigate anomalies in greater detail.

In water survey

- Ascertain ‘background’ methane and crude oil measurements
- Run a series of parallel transects “mowing the lawn” to intersect the plume in the water column
- Use the near real time data to inform the survey plan (locate the sea bed source)

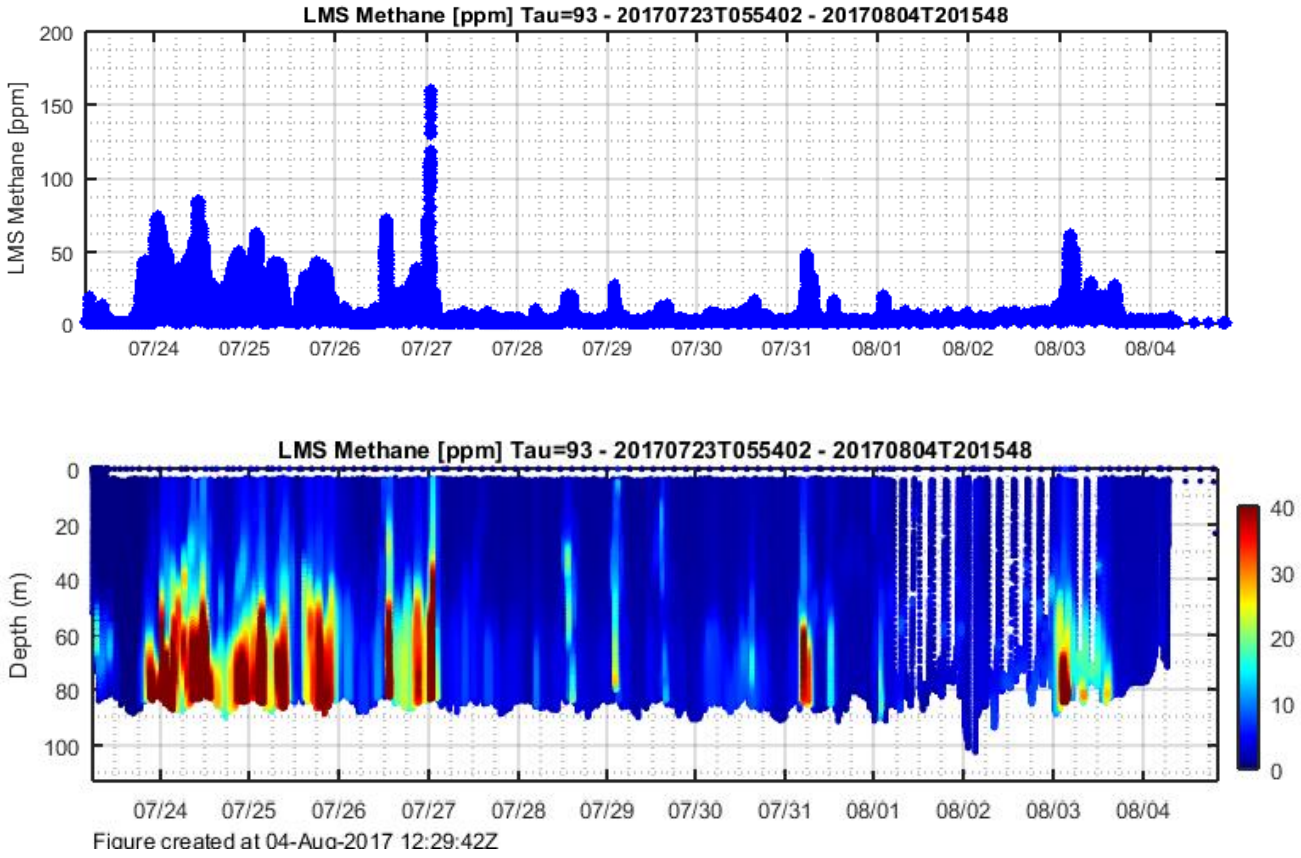


Map of glider transects (plan view)

DATA HIGHLIGHTS

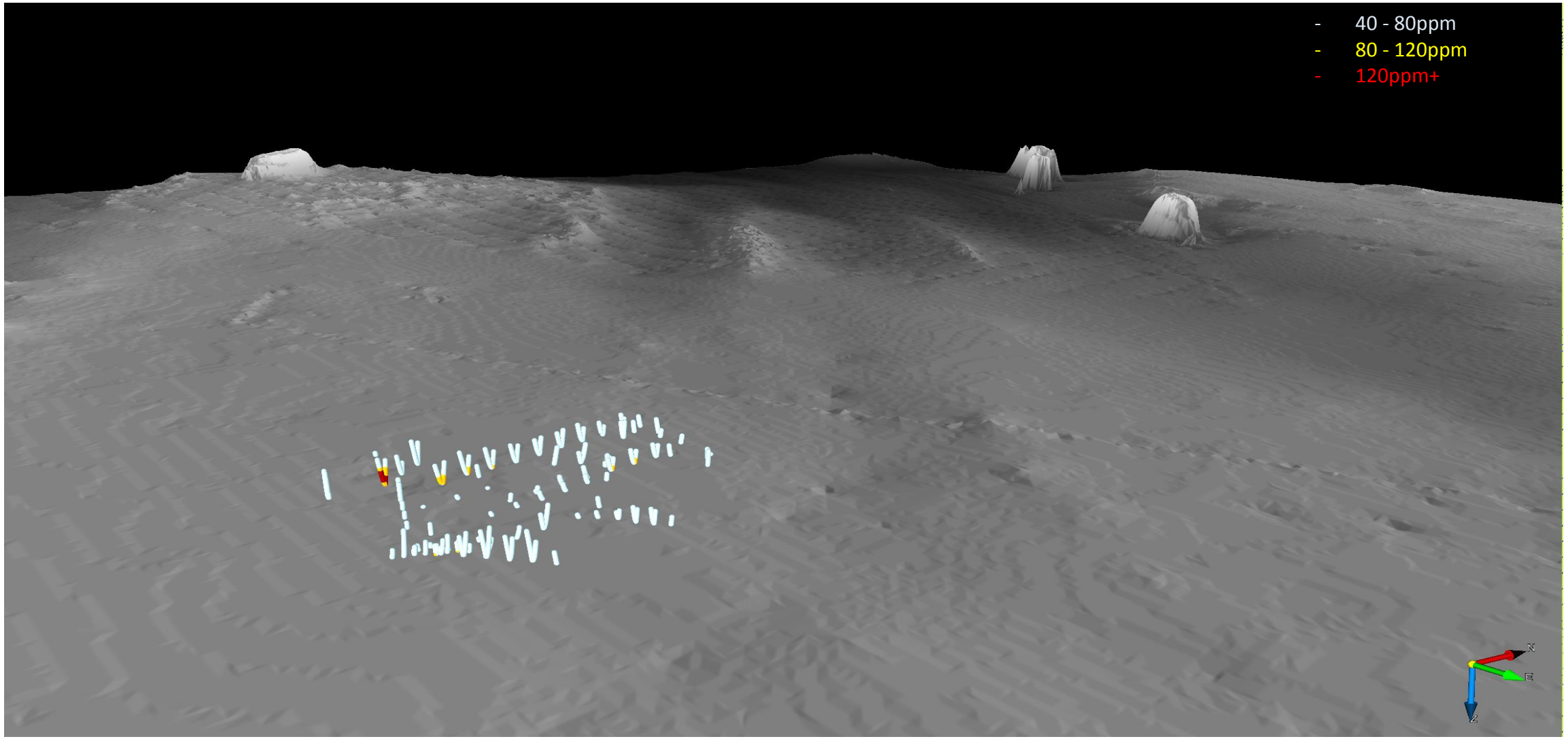
Multiple sensors on one vehicle allows for greater confidence in measurements.

- **Excellent sensitivity.** High methane concentrations recorded (40 times background) which correlates well with historical data
- **Thermogenic discrimination.** Maximum fluorescence measurements indicate good spatial relationship with high methane concentrations
- **Currents govern diffusion.** High methane concentrations have been detected 8km apart



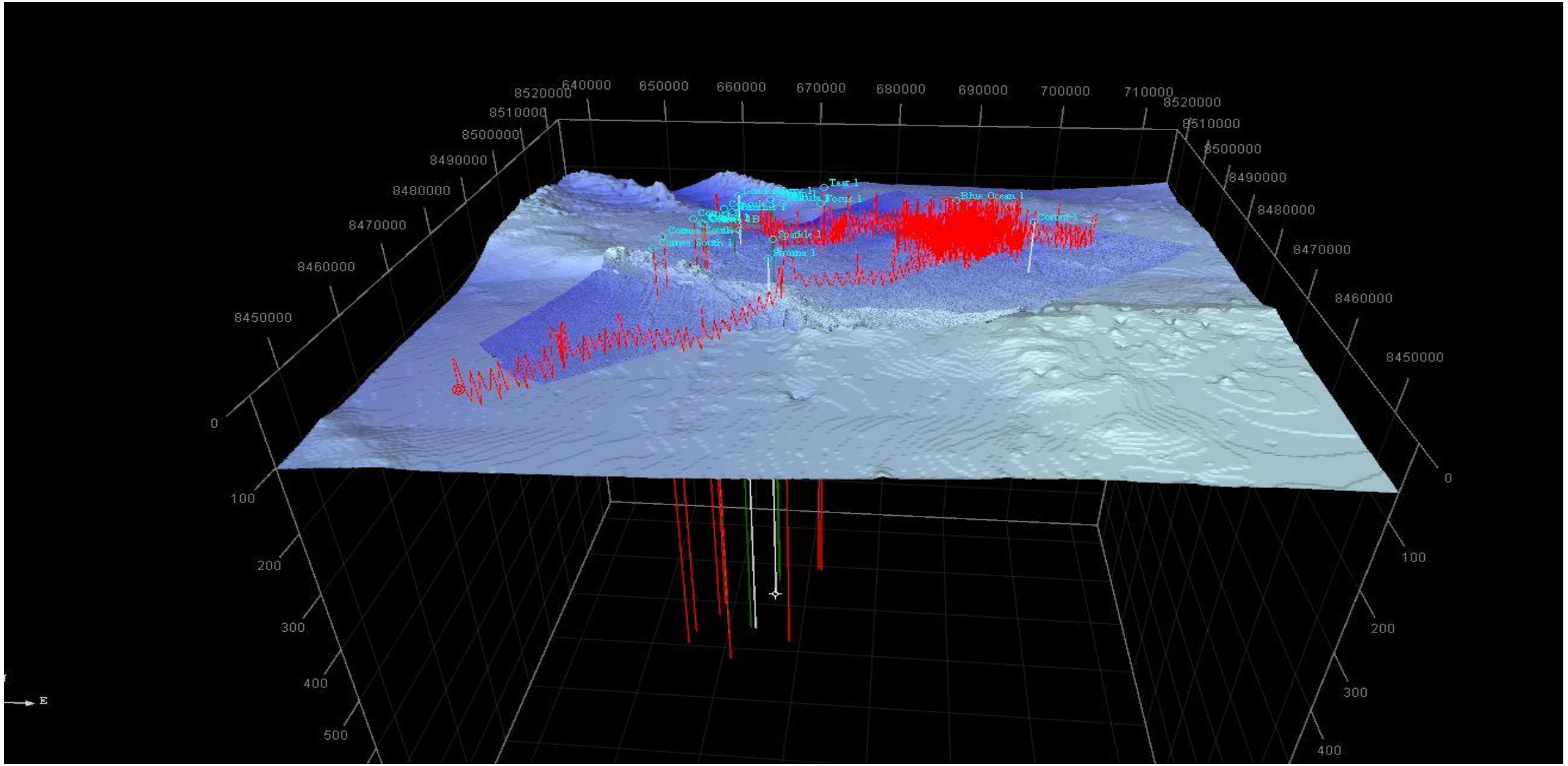
Methane concentration against time

REGIONAL SCALE



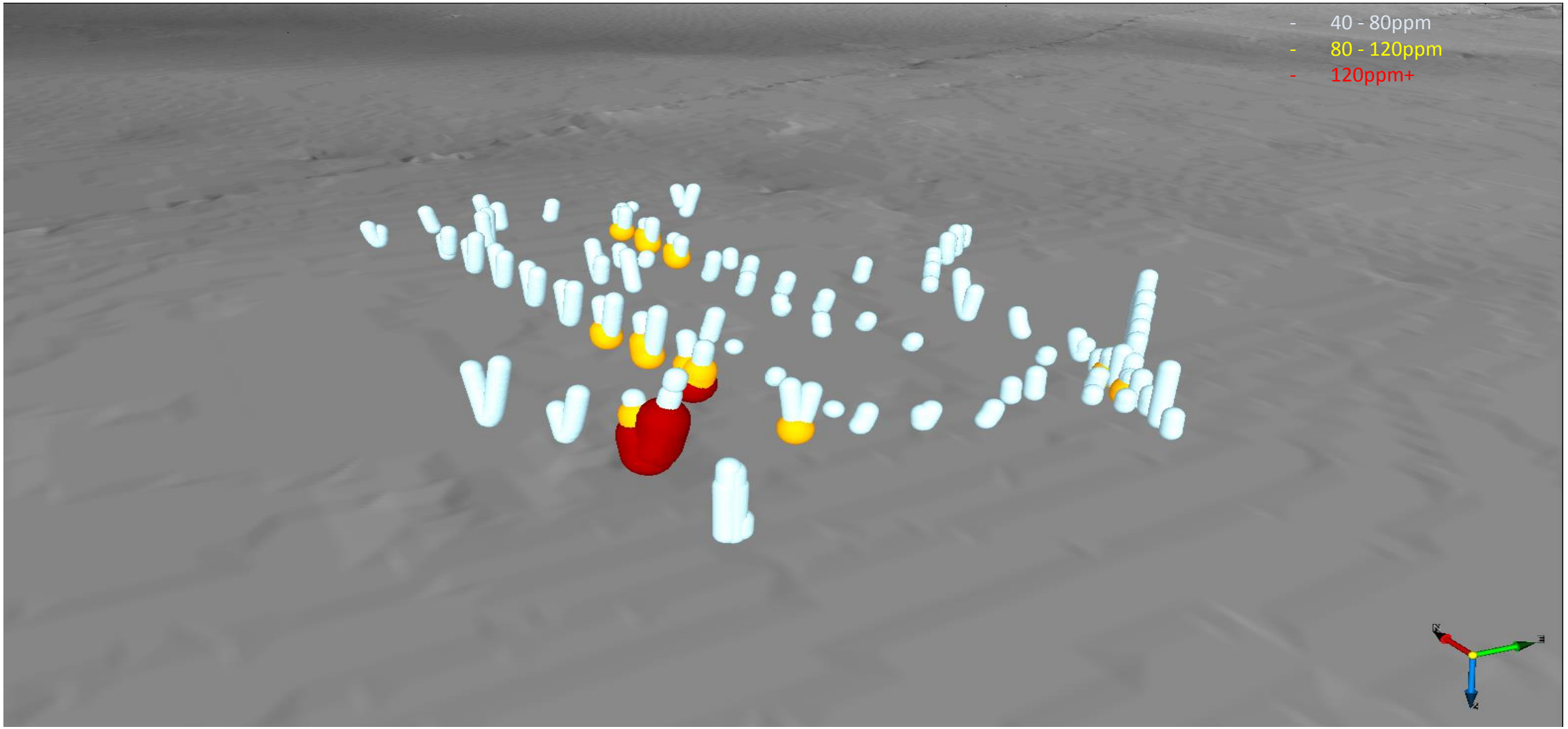
Methane anomalies against bathymetry (regional scale)

SURVEY AREA



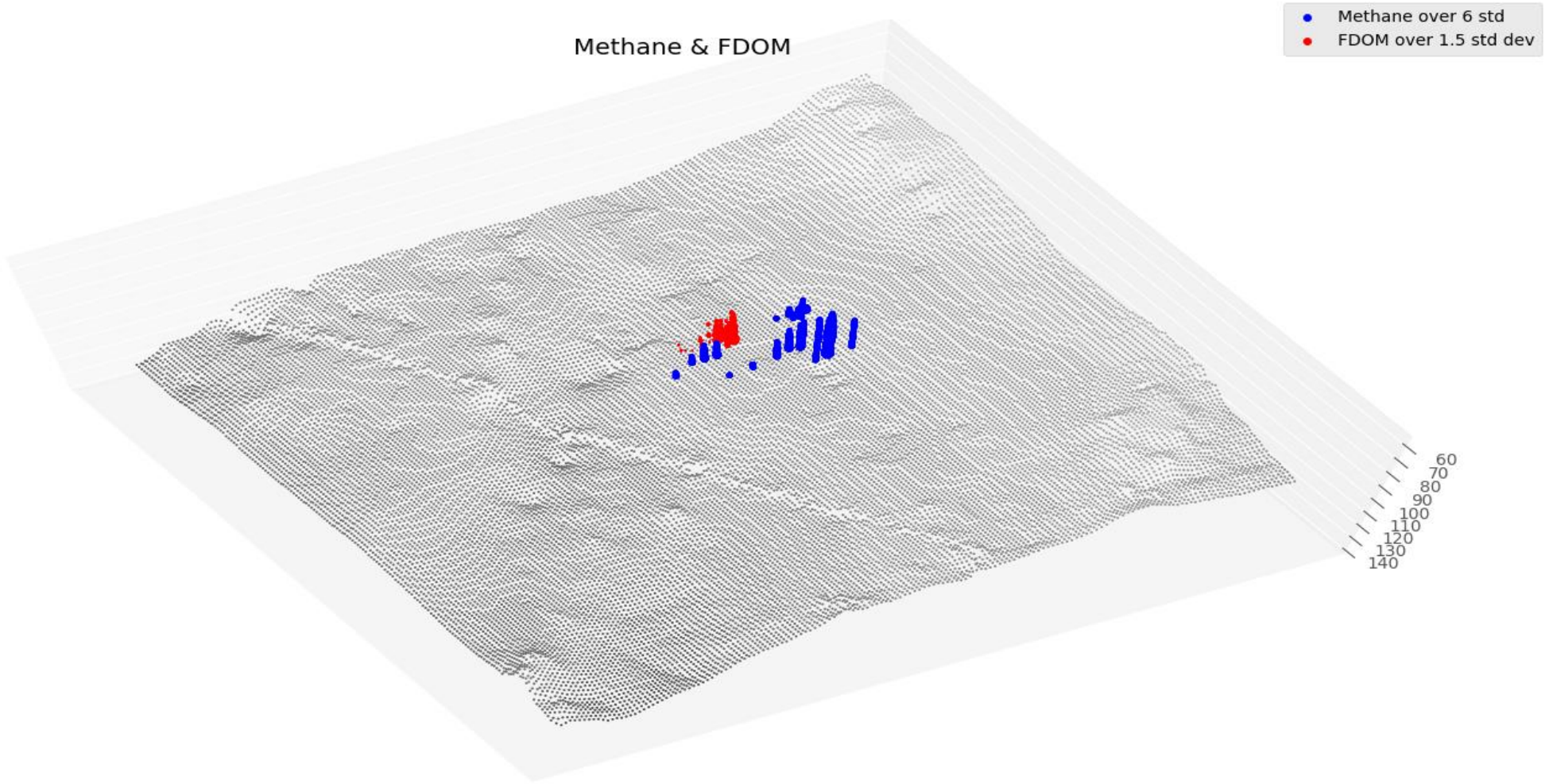
Water column and subsurface visualization. Glider survey track with well information

METHANE ANOMALIES



Peak methane measurements in space

METHANE AND FLUORESCENCE

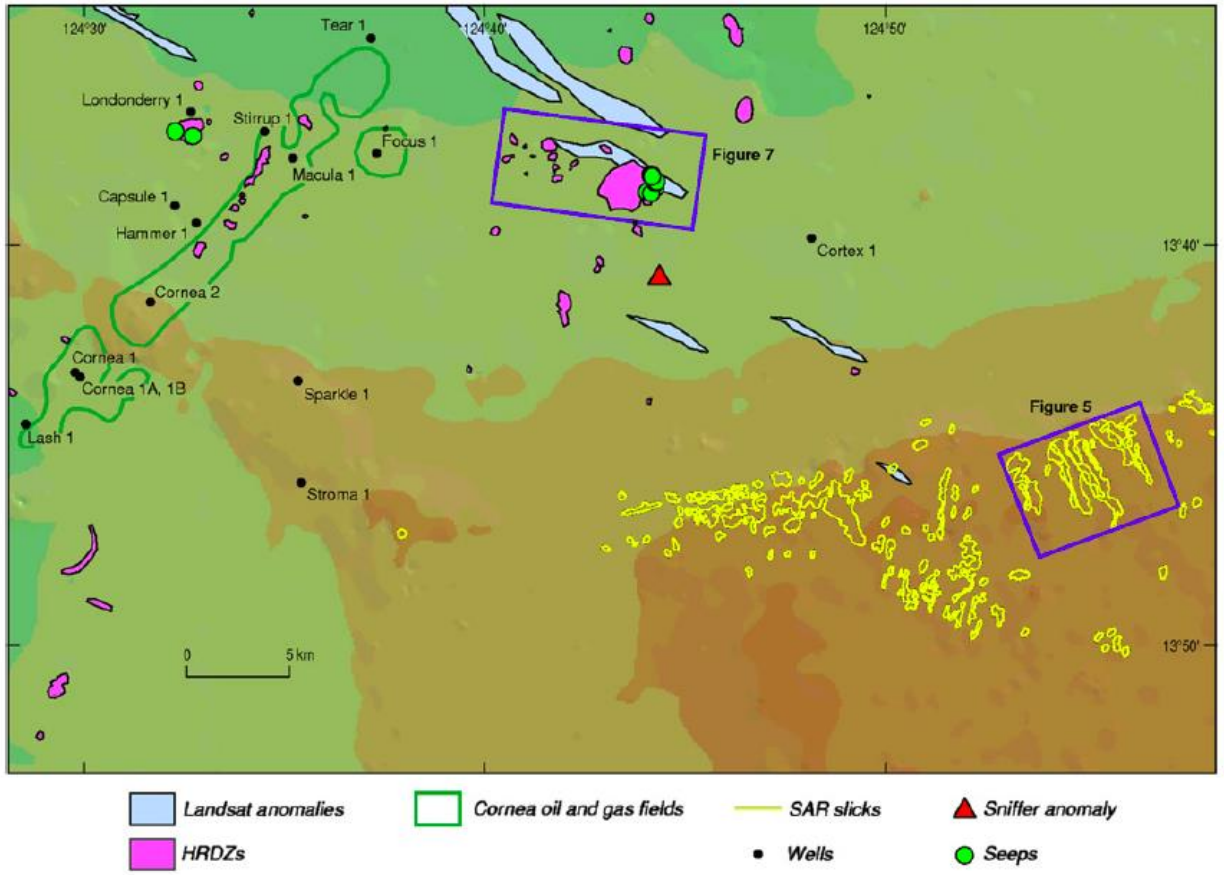


Peak methane and fluorescence measurements in space

APPLICATION FOR EXPLORATION

Explore smarter.

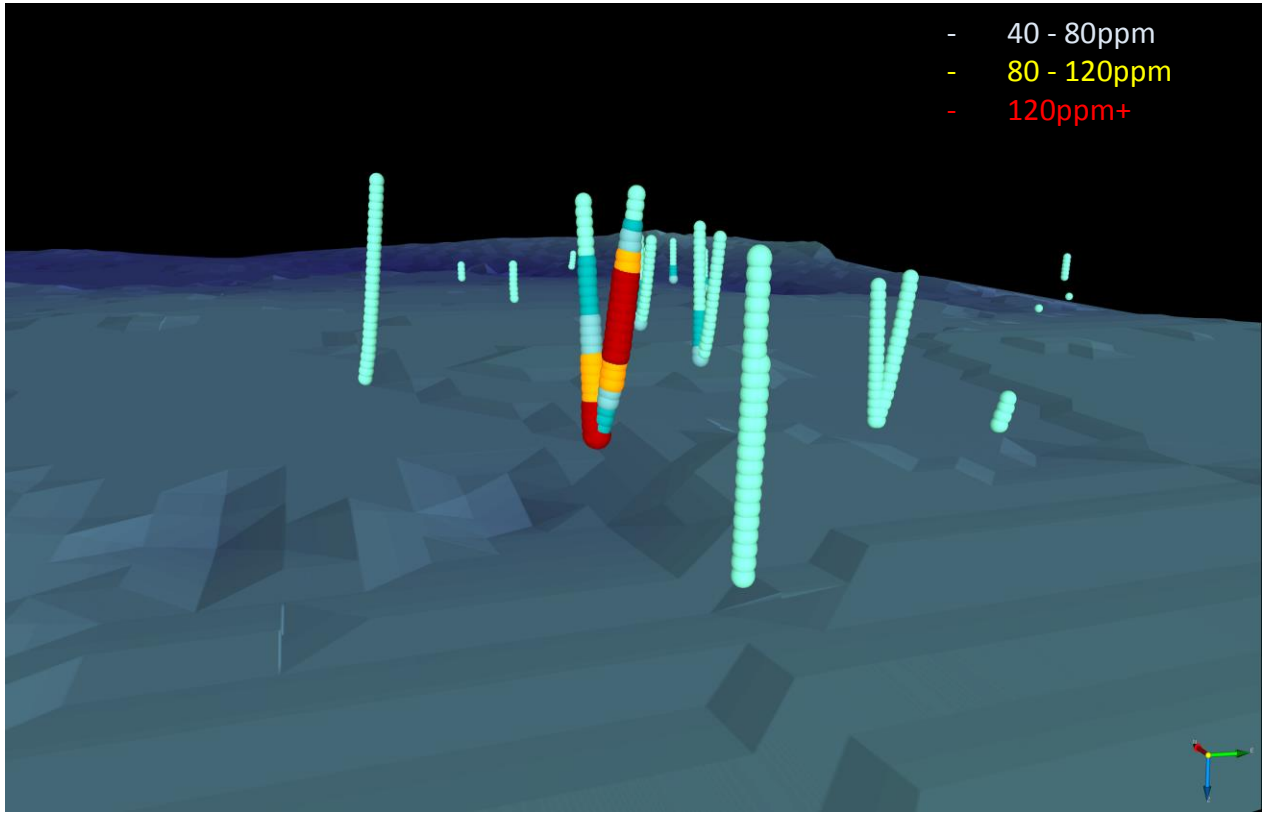
- **Remote sensing first.** In frontier basins SAR will provide an early lead
- **Glider ground truthing second**
- **Detailed investigations to follow**
  - Geophysical surveys
  - Core sampling



Geoscience Australia – Rollet et al, 2006.

CONCLUSION

- **Gliders – the future of marine geochemical surveys?**
- **Very cost effective, great spatial and temporal data coverage and reduce HSE risks**
- **There are areas for development but the future is exciting**



Peak methane measurements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