

Seismic data acquisition on the seabed

The Age of Enlightenment

Agenda



- What lies beneath?
- Why Seabed?
- Why Seabed Geosolutions?
- Examples
- Good information leads to good decisions and good economics
- Summary and Conclusions



What lies beneath?

- Without light you won't see anything
 - Grab a torch to illuminate the object.
- You see an object, it's the right size but are you sure of it's position?
 - Look at it from all possible angles
 - Look at it from different distances
- What is the nature of the object. What colour is it for example?
 - Think about the light you are using to illuminate it and don't forget you wearing sunglasses Sean
- What if there it was at the shallow end of the pool and there was a big airbed floating above it?
 - You'd need to get close to the surface and maybe a mirror would be helpful
- What if the jacuzzi is on with bubbles obscuring your view?
 - Wouldn't it be useful to see through the bubbles?
- Is the box empty or full?
 - Wouldn't it be great to be able to give it a poke with a stick and see how it feels?



Decision de-risking

- Good decisions lead to efficient and profitable actions
- To make the best decision 007 needed the best information available.
- The oil company is our smartly dressed but cautious hero
- The seabed seismic acquisition contractor is offering tools that allow gathering of the information to de-risk the decision.

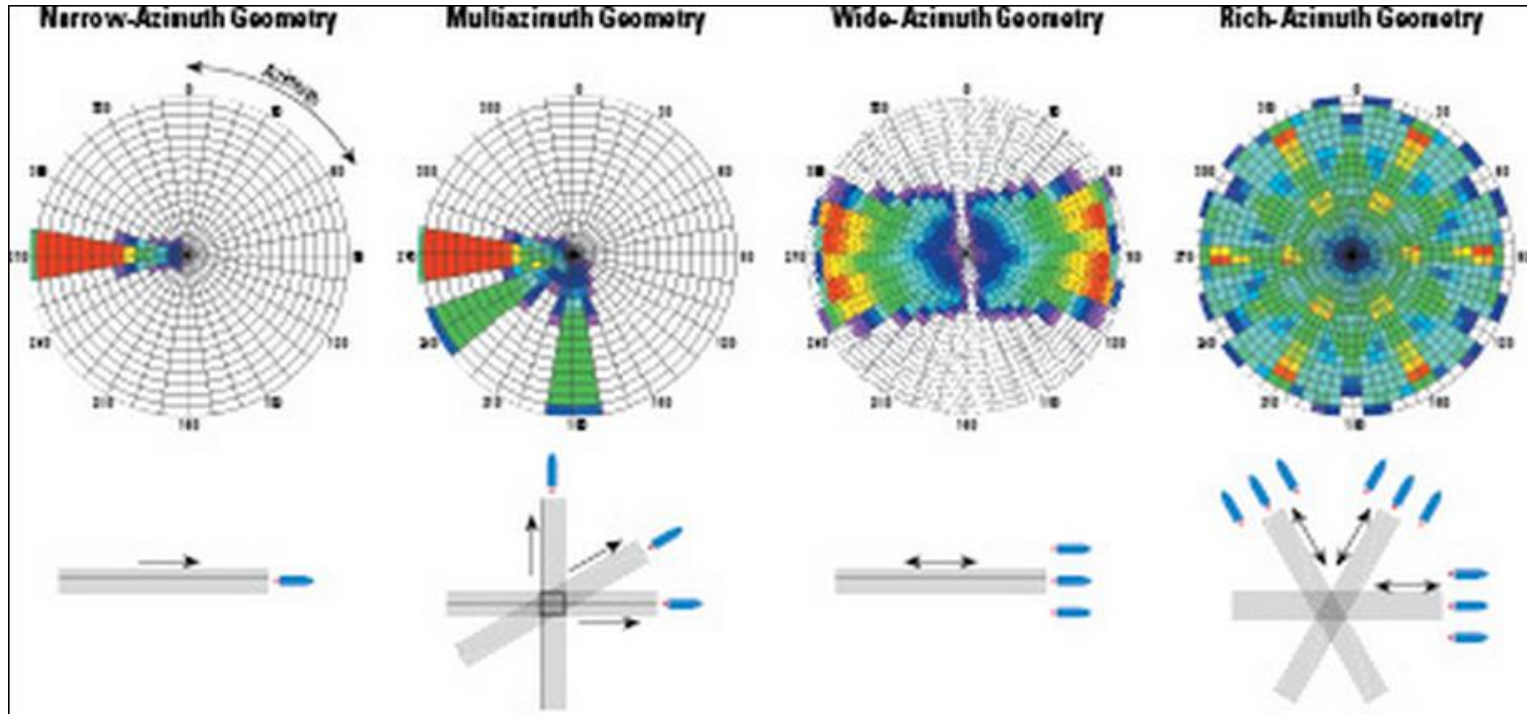


What is in the tool box?

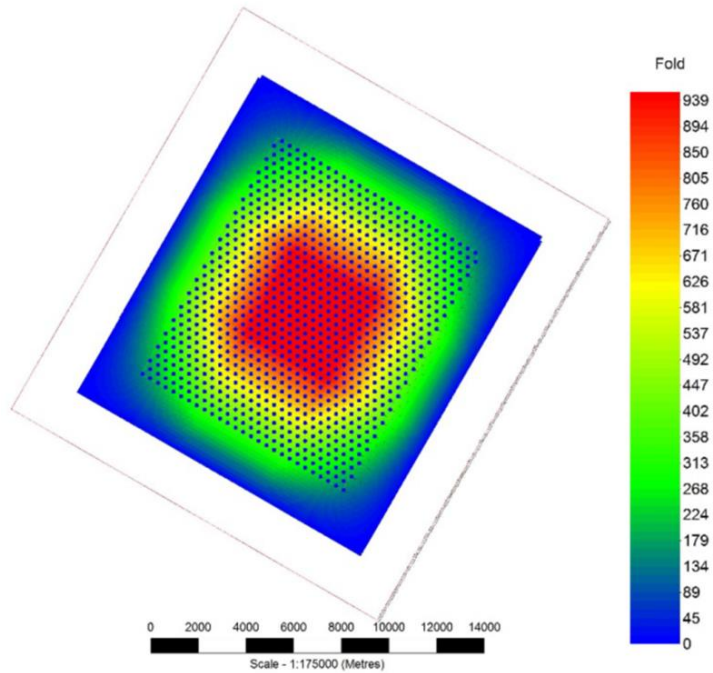
- Torch Light = sound wave
- Looking from different directions = full azimuth data
- From different distances = Full offset data
- White light = Broadband sound
- Seeing past the obstruction = listening on the seabed bouncing waves off the sea surface
- Seeing through bubbles = shear waves
- Determining characteristics of the material in question = inversion using shear waves



What can conventional streamer acquisition deliver?



What can ocean bottom seismic deliver?



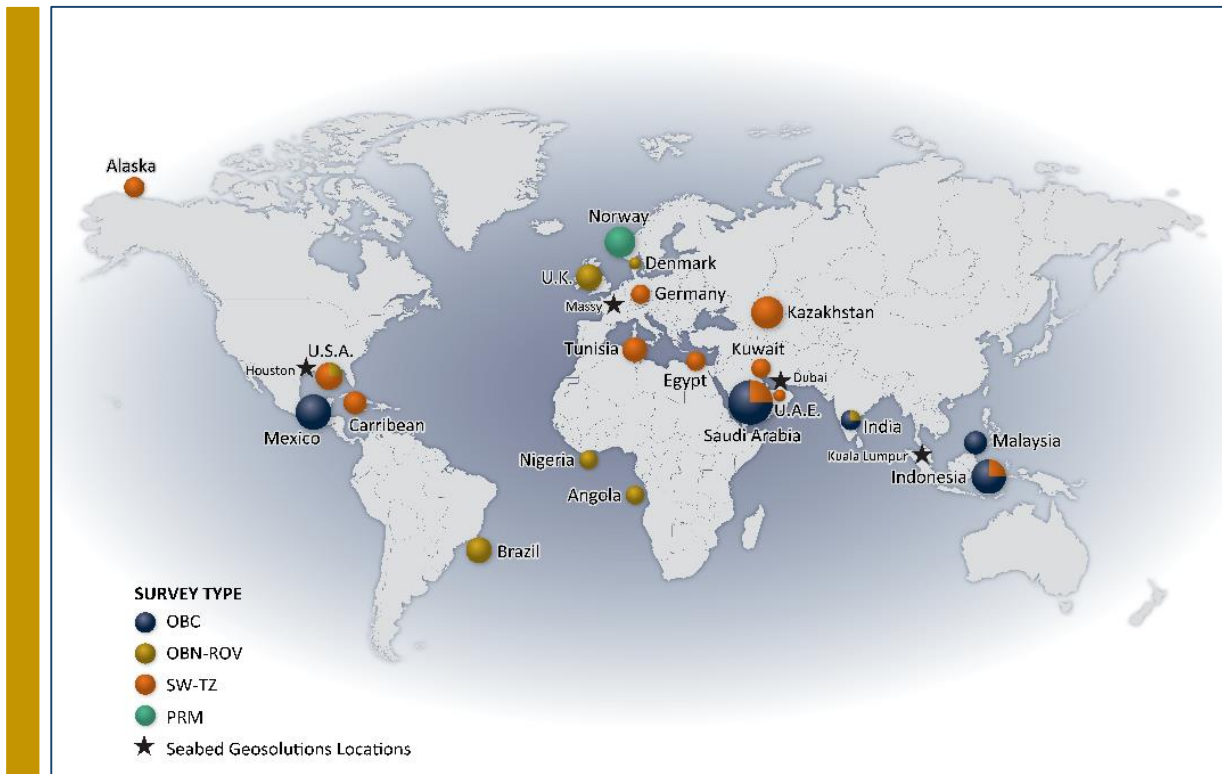
What Does Seabed Geosolutions Deliver?

- Global expertise acquiring seabed multicomponent data
- Comprehensive, custom-designed ocean bottom seismic acquisition services
- Utilizing leading technology to resolve operational and geophysical challenges in water depths of 0 - 3000 meters
- Delivering high-resolution broadband images of the subsurface - full azimuth, long offsets to improve reservoir illumination
- DERISKS DIFFICULT DECISIONS



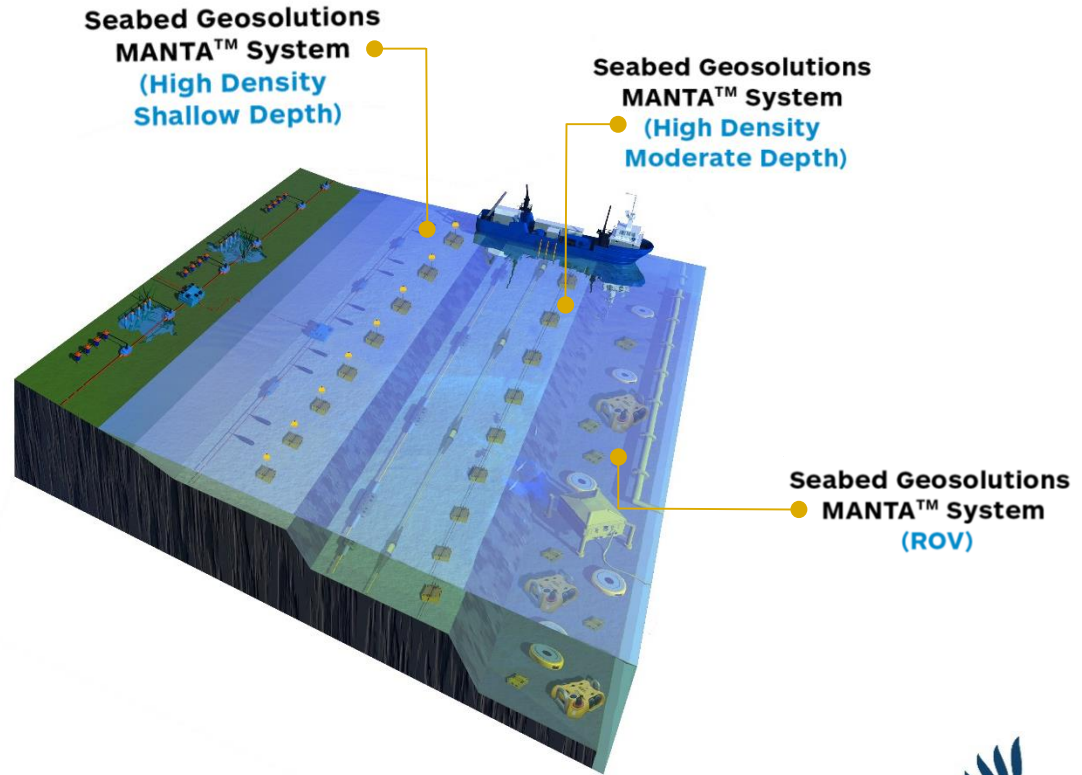
Global Experience

- Extensive global expertise with more than 25,000 km² of seismic data collected since 2005

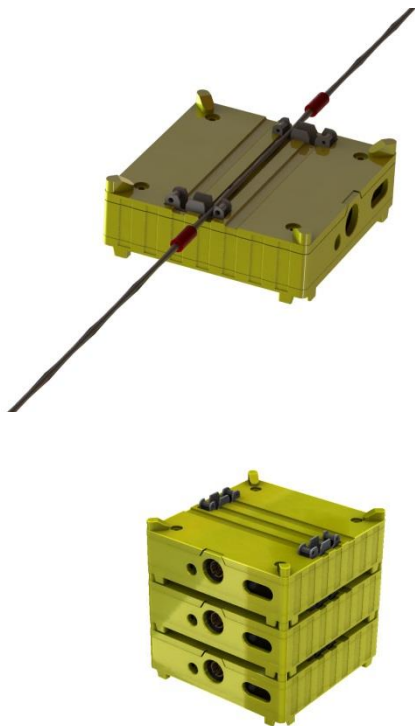


Operating Environments

- Marine environments from transition zone to deepwater
- Soon we will have a 4 component sensor package call Manta that can operate in unlimited water depth and in unlimited geometries.



Manta™ OBN - a Step Change



- Compact node design enables higher node count
- Variable in-line receiver spacing to optimize cost
- Flexible, highly automated deployment and recovery for safe and efficient operations
- Advanced rechargeable power-dense battery technology
- Single design for all water depths ranging from 0 – 3000 meters





What about in the real world?

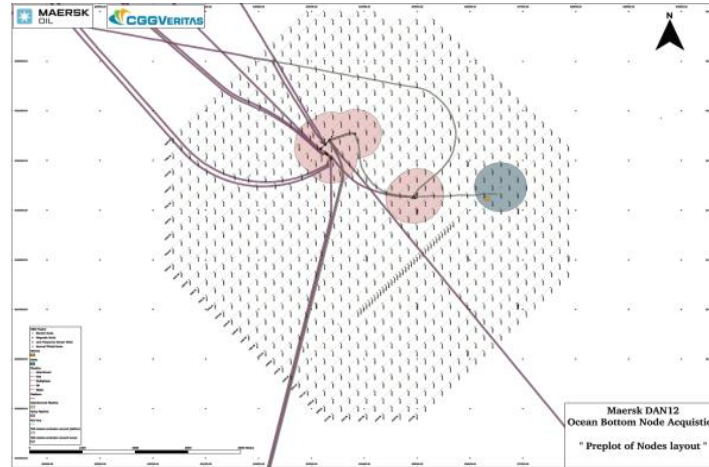


Dan Field - North Sea Danish sector



- Chalk reservoir
- Complex structure
- Water injection

- 225m node interval
- 37.5m shot interval

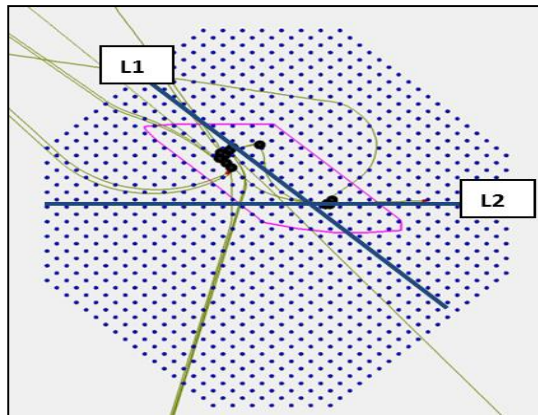
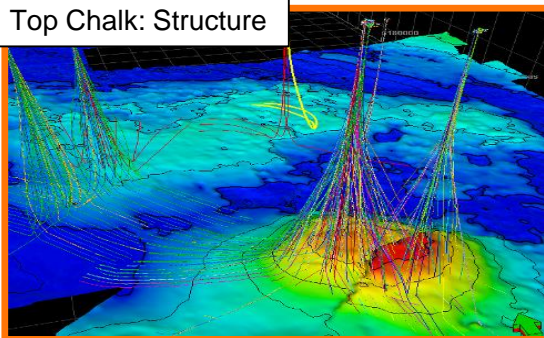


- Streamer baseline survey
- 2012 4D monitoring survey: combined streamers and nodes



Dan Field

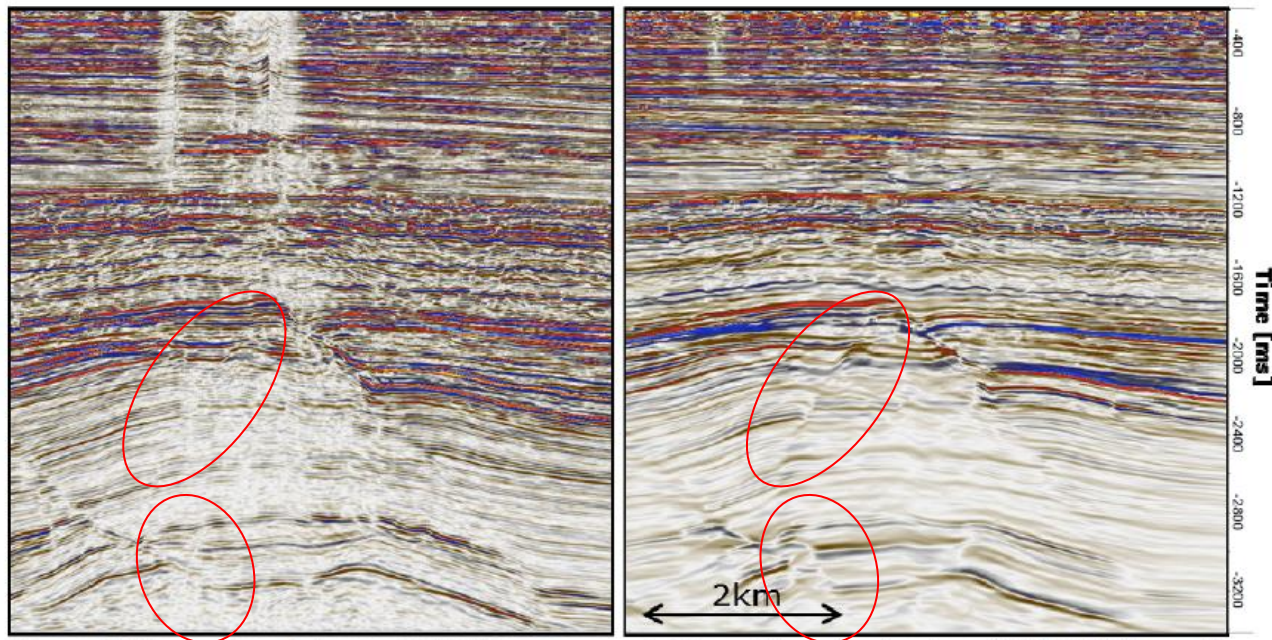
Top Chalk: Structure



- Dome structure, main fault, gas cap
- Challenging chalk reservoirs, low permeability, high porosity
- Production since 1972; water injection since 1988
- 108 active wells
 - 58 oil producers
 - 50 water injectors
- Seismic data
 - 1988, 2005: streamer
 - 2012: Streamer + OBN
- OBN survey layout
 - 225x225m node patch
 - 37.5x37.5 shot patch



Streamer to OBS comparison - Maersk Dan Field

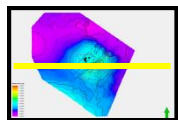


2012 Streamer with infill

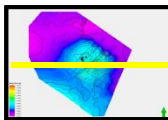
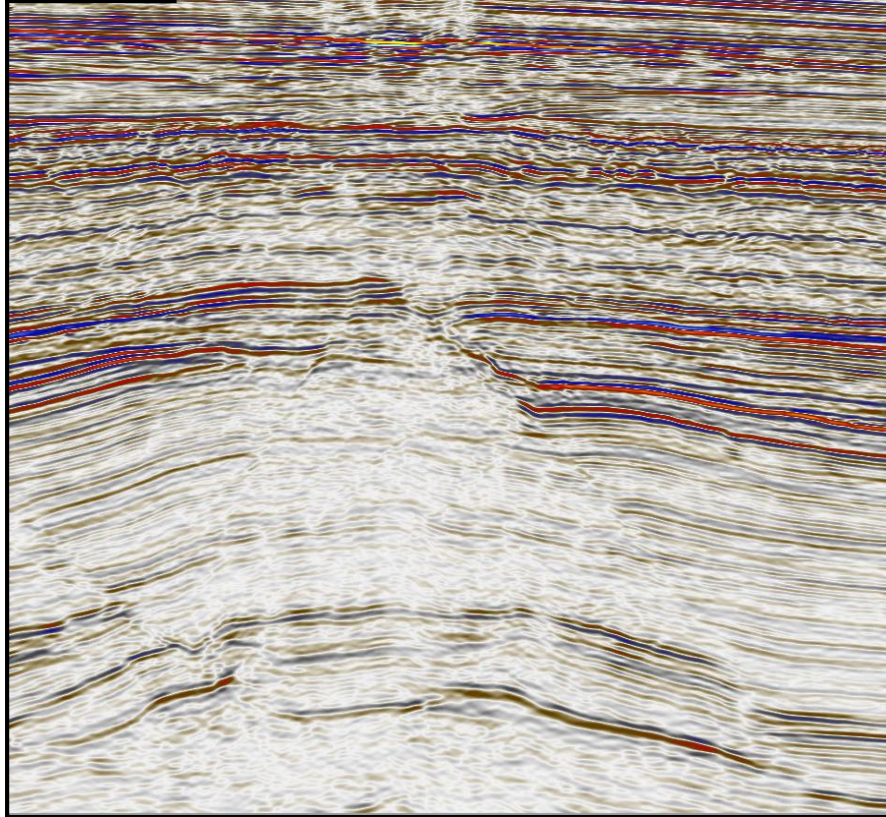
Ocean Bottom Seismic

Images courtesy of Maersk

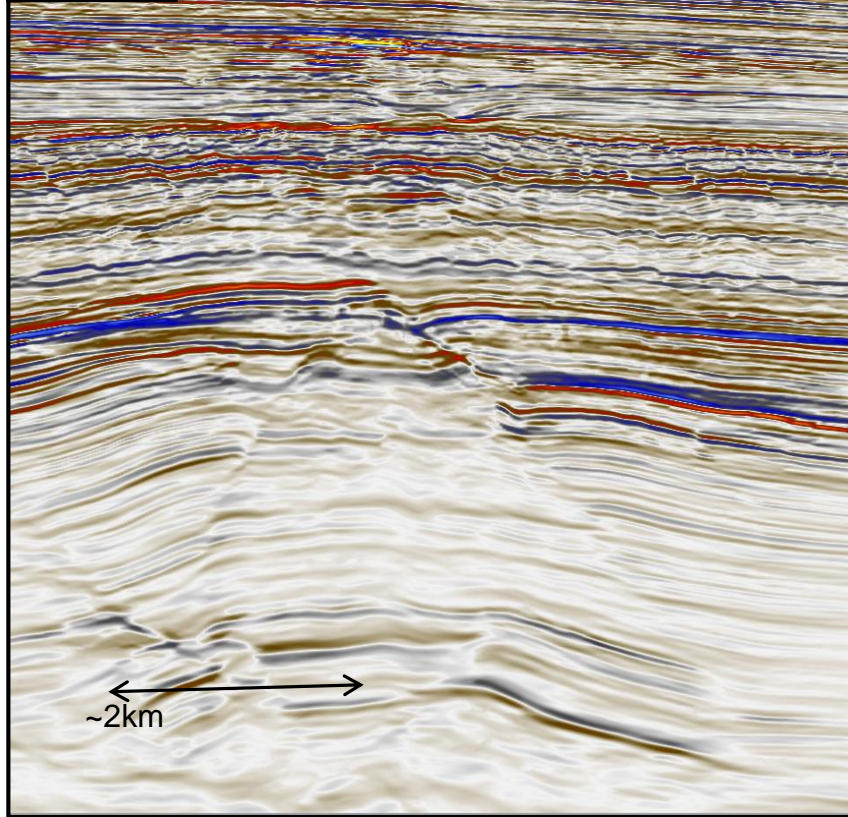




1. Streamer 2012



2. OBN 2012



CABGOC TL (Angola)



- Resident ROV vessel: the ROV vessel stayed on the field. No node vessel transiting
- The nodes and the handling equipment flown to Pointe Noire and trucked to Malongo
- CABGOC provided the (DNV271) containers and much appreciated help
- Shipped by PSV to TL field



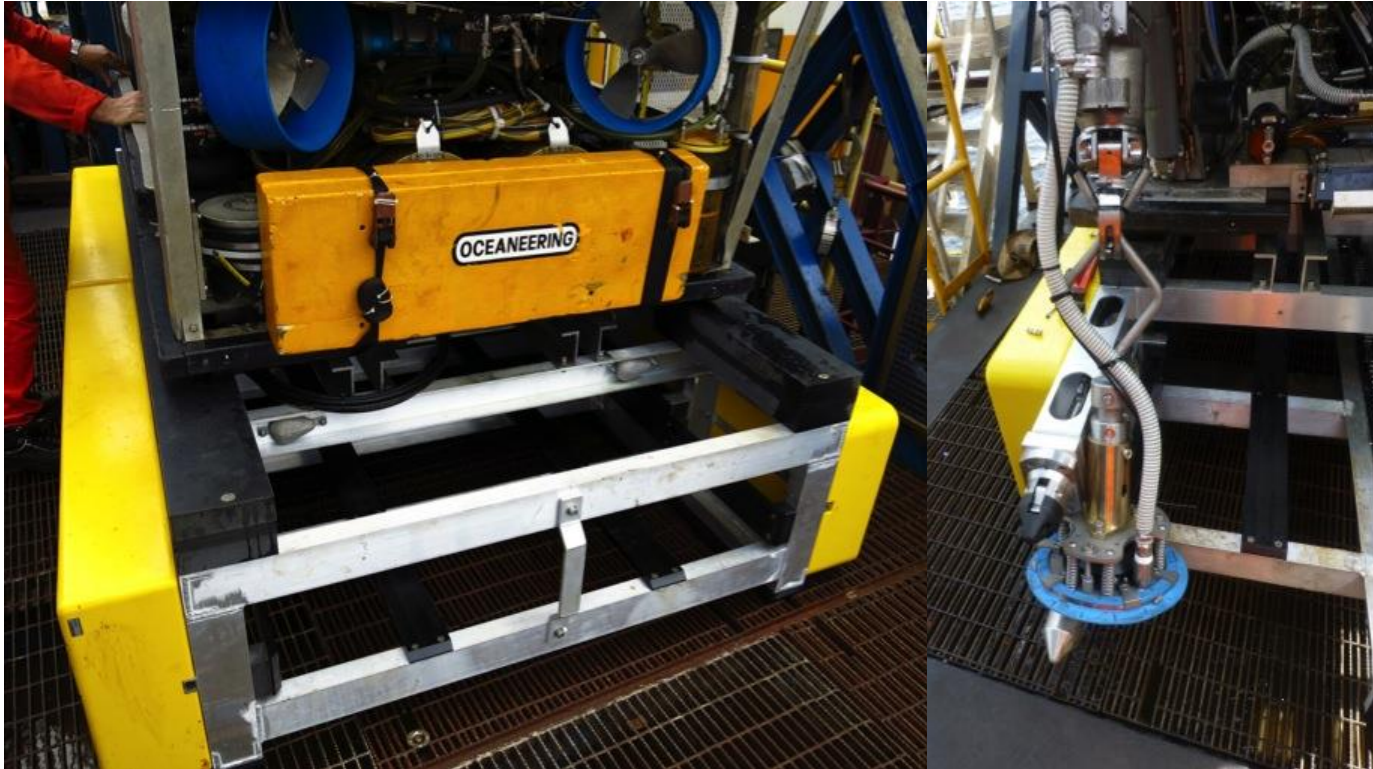
Platform Crane from the PSV



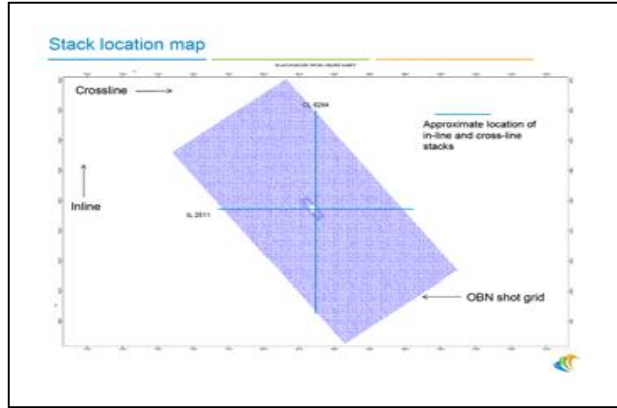
Nodes and Crew in Containers



ROV Skid and Node Handling

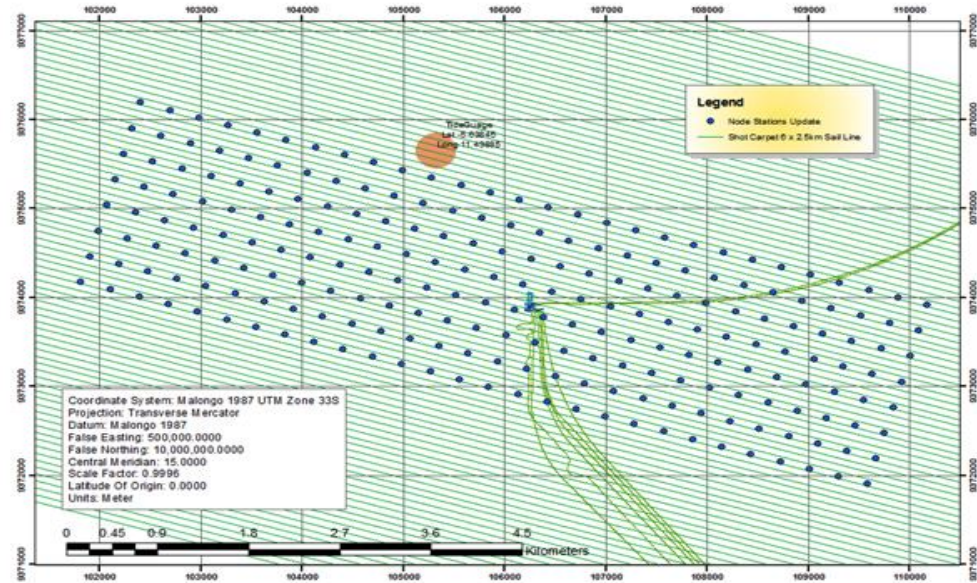


TL Platform Undershoot

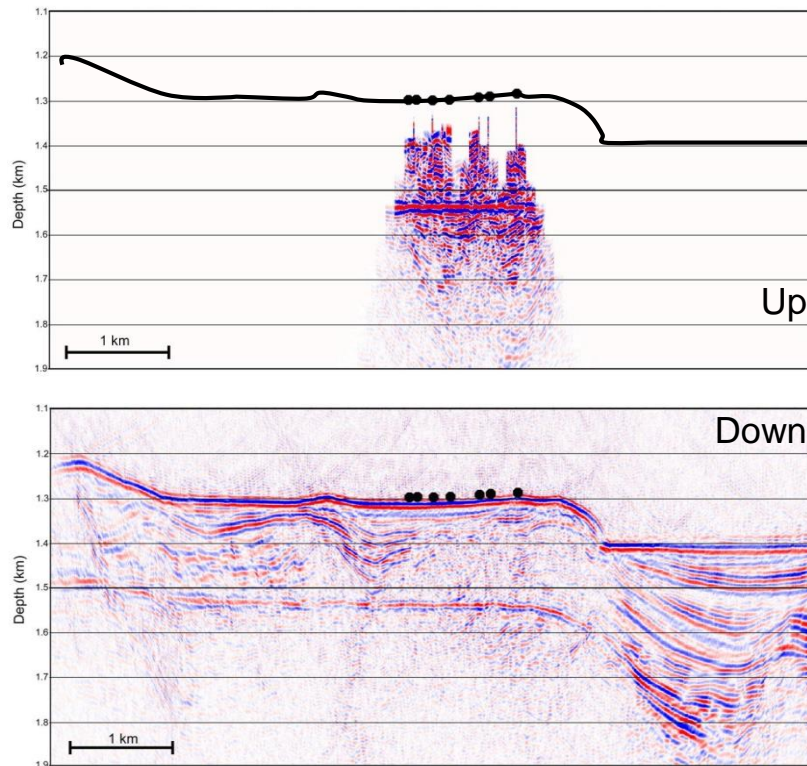


Rx distance: 300 m
Sx distance: 37.5 m
Min in-line offset: 2.5 km
Min x-line offset : 2.5 km

WD 320-440 m

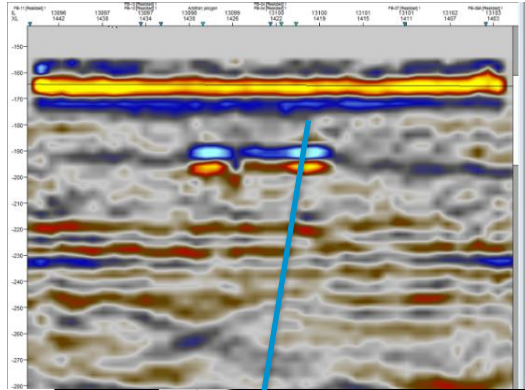


Remember the mirrors

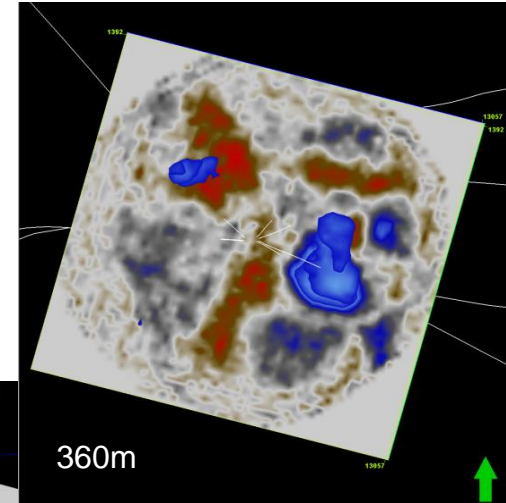
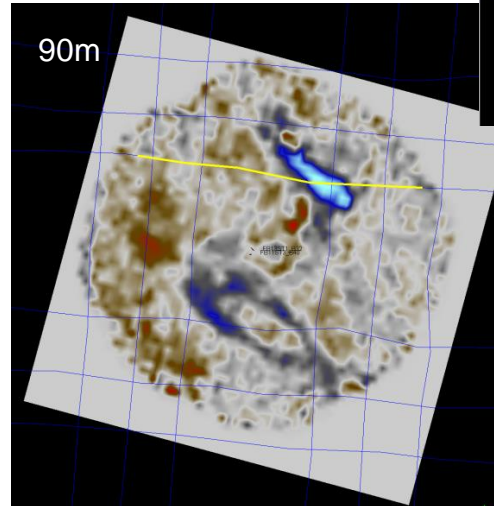
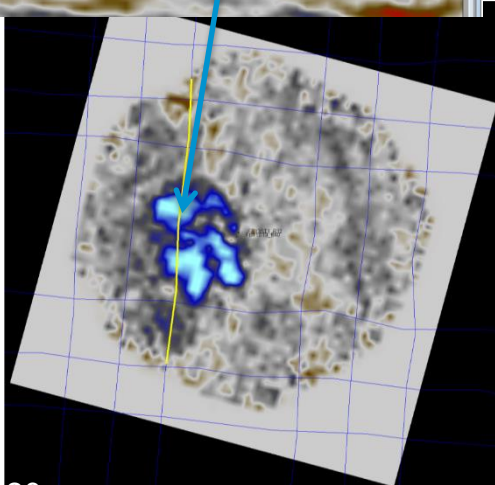


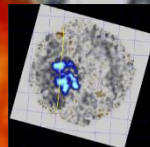
Dash et al, 2009

Avoiding the jelly fish



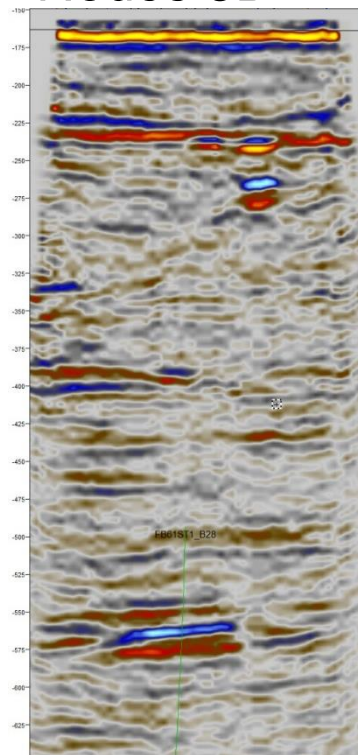
Down-going OBS data provides 3D image of hazards below platform as shallow as 20m below seabed



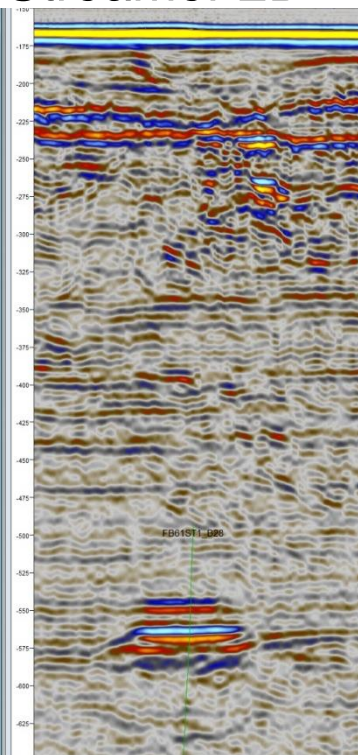


Time slice
20m below
the seabed

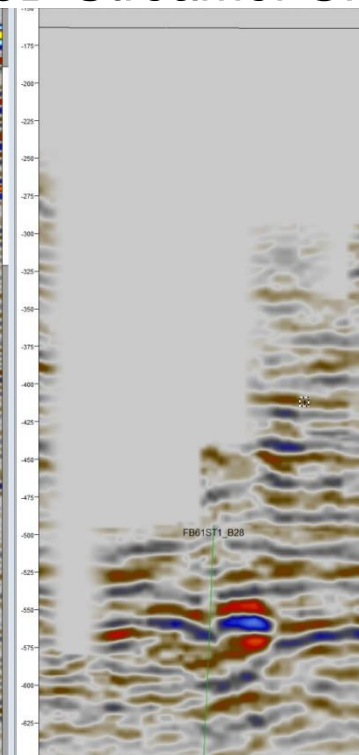
Nodes 3D



Streamer 2D



3D Streamer Undershoot



The Jacuzzi conundrum

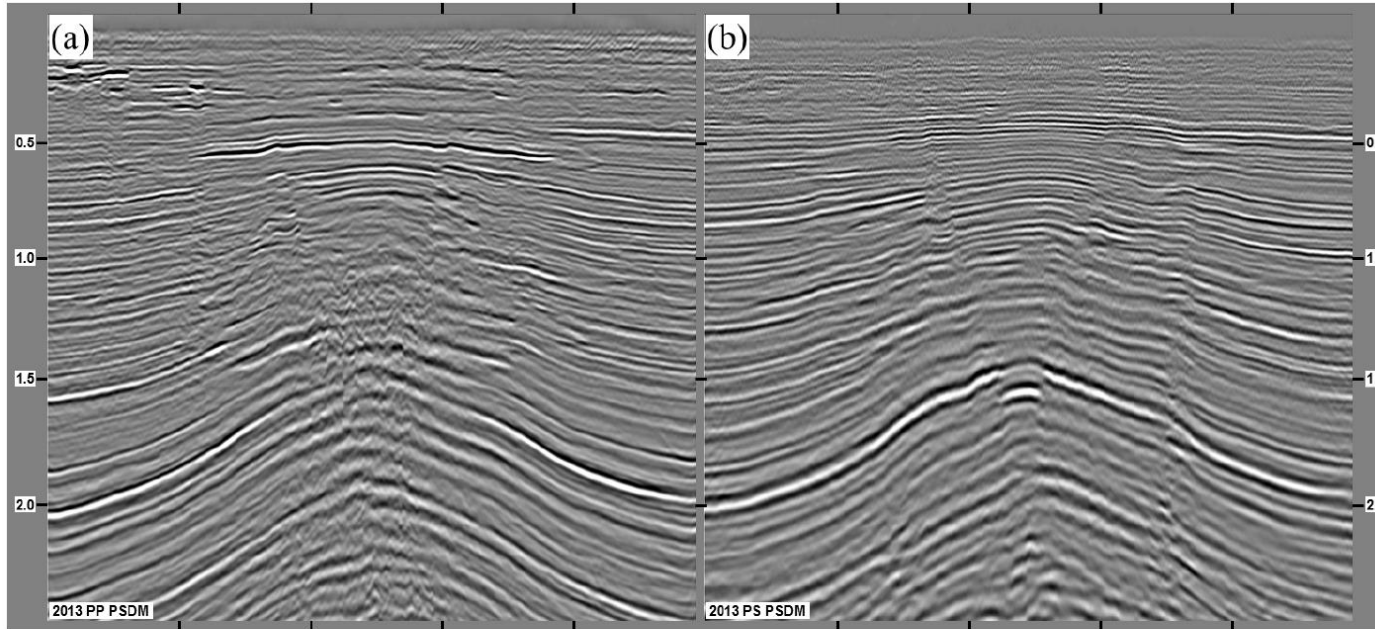
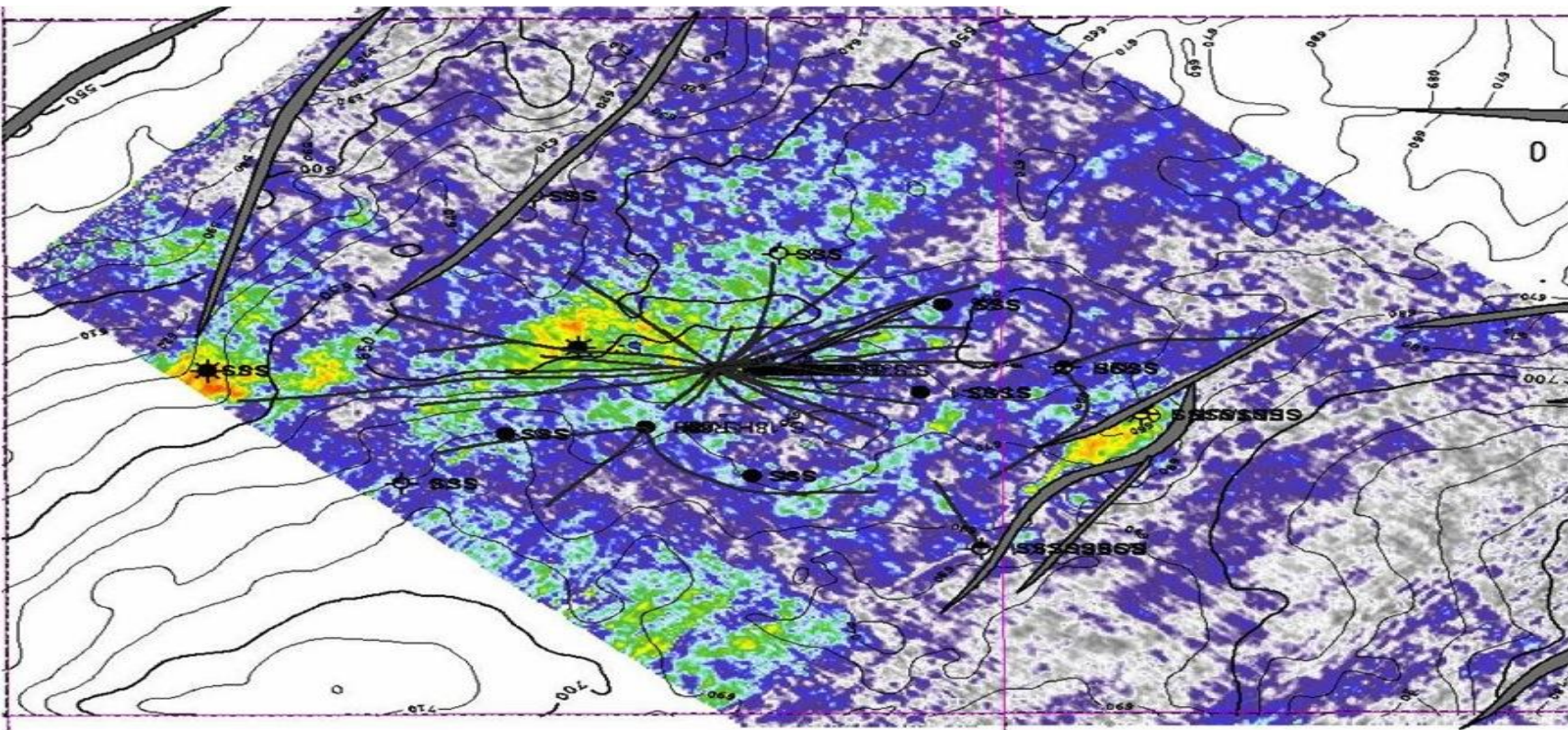


Figure 6 Comparison of PP-PSDM and PS-PSDM stacks in depth domain.



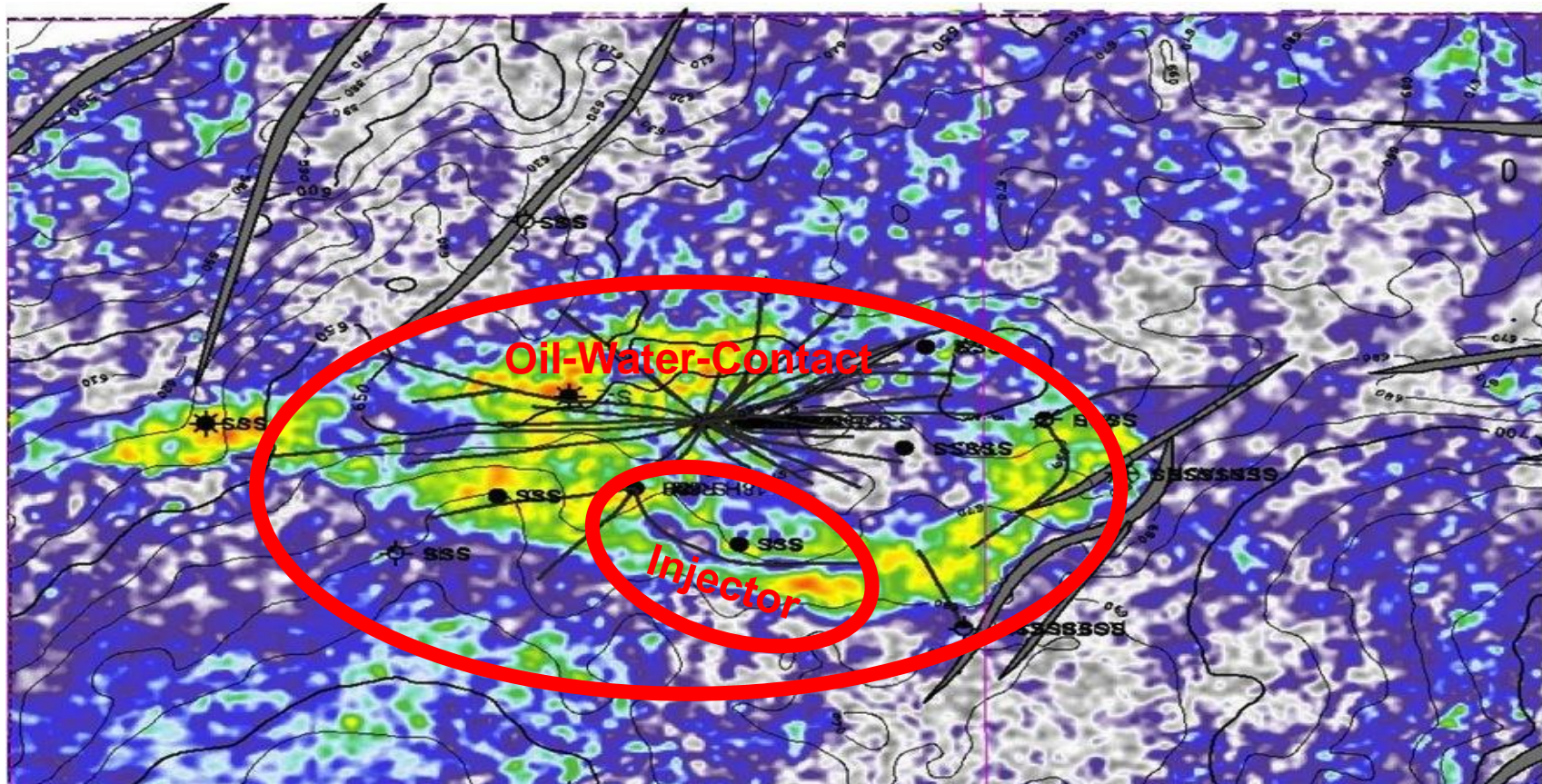
Streamer data

Data Courtesy of Apache



Seabed data

Data Courtesy of Apache



Value of Information

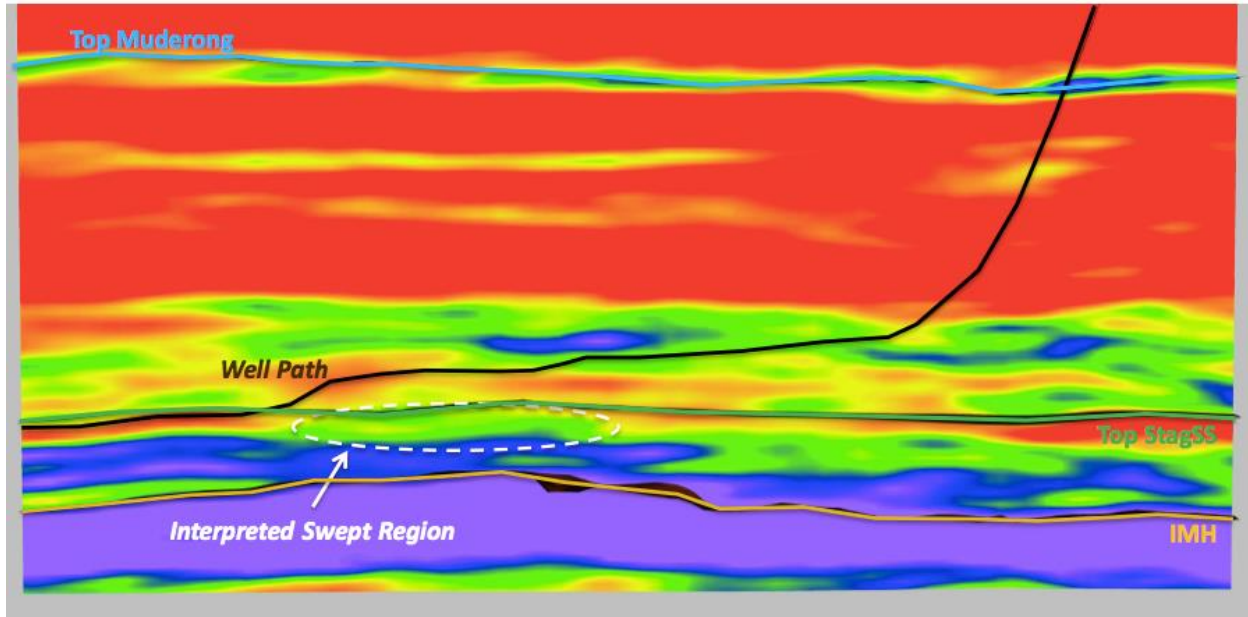
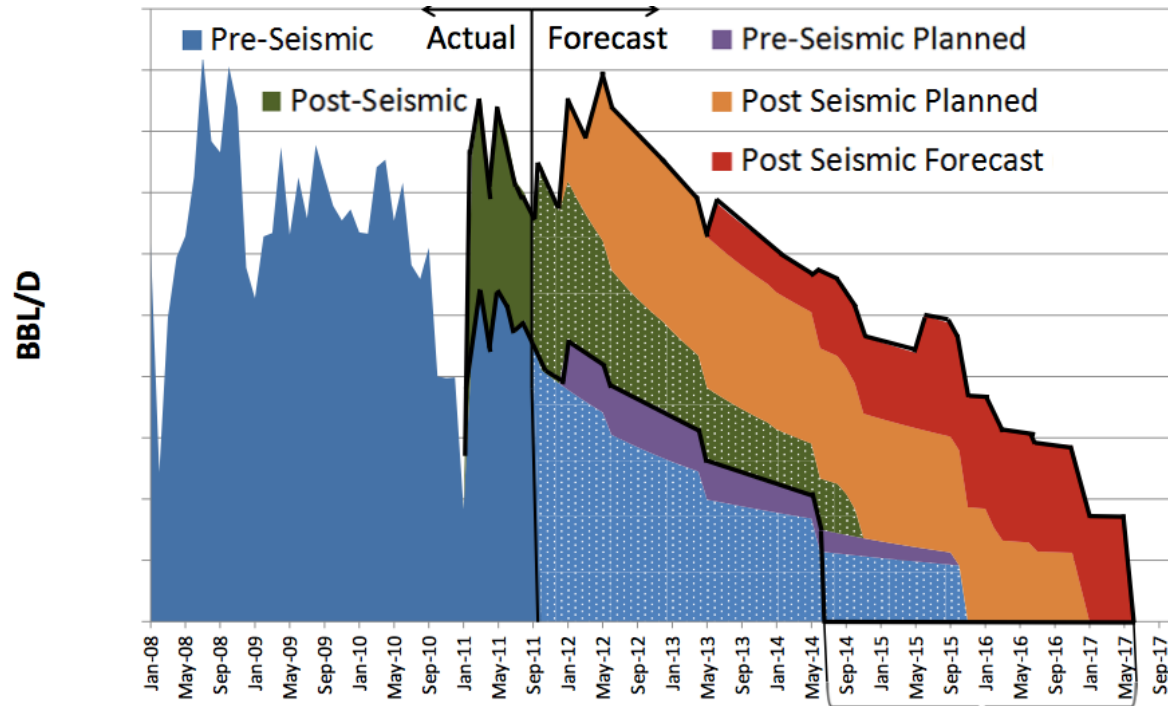


Figure 7 – Production well P-1 actual path shown on P-Impedance cross-section from joint multicomponent inversion. Region highlighted in ellipse has been interpreted to be a swept region which was avoided by this well path.



Value of Information

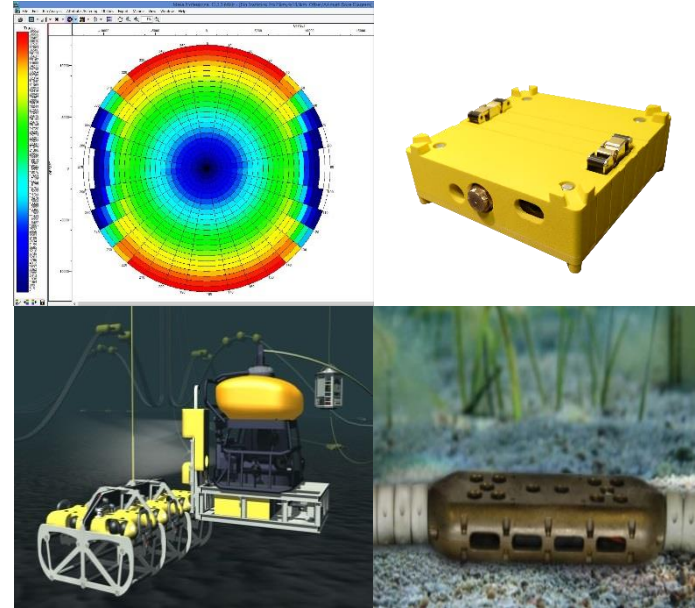


7.3 MMbbls of Additional Post-Seismic Oil & Extended Economic Life by 3 years



Summary

- Ocean bottom seismic offers the best azimuthal coverage
- Recent developments have led to larger spreads
- Unparalleled imaging around and under obstructions
- Seabed Geosolutions has the tools to give you the full picture and help you make enlightened and profitable decisions



Conclusion

- Welcome to the Age of Enlightenment

