# Seismic data acquisition on the seabed

## The Age of Enlightenment



Seabed GEOSOLUTIONS

# 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
- What about the depth?
  - 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?

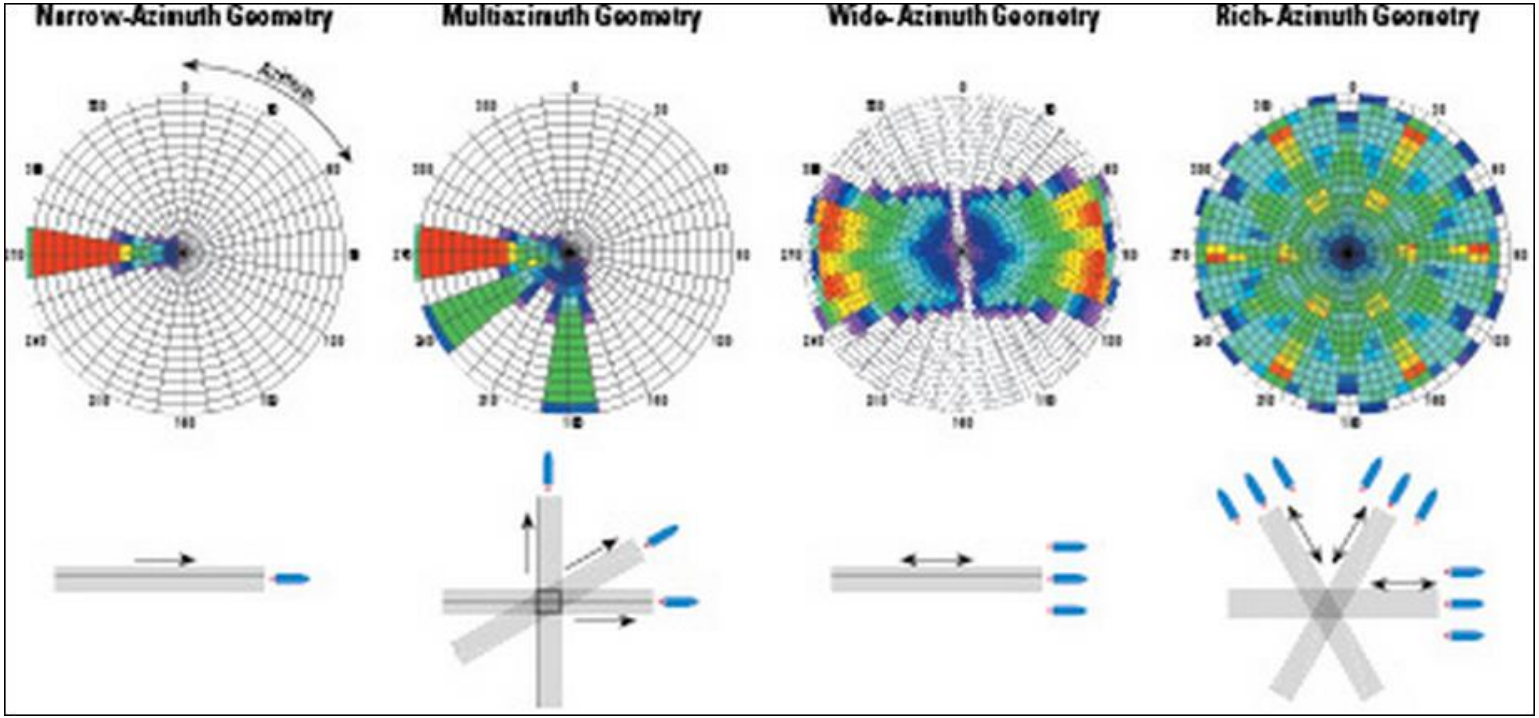
# Decision de-risking

- 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 Q - offering tools that allow gathering of the information to de-risk the decision.

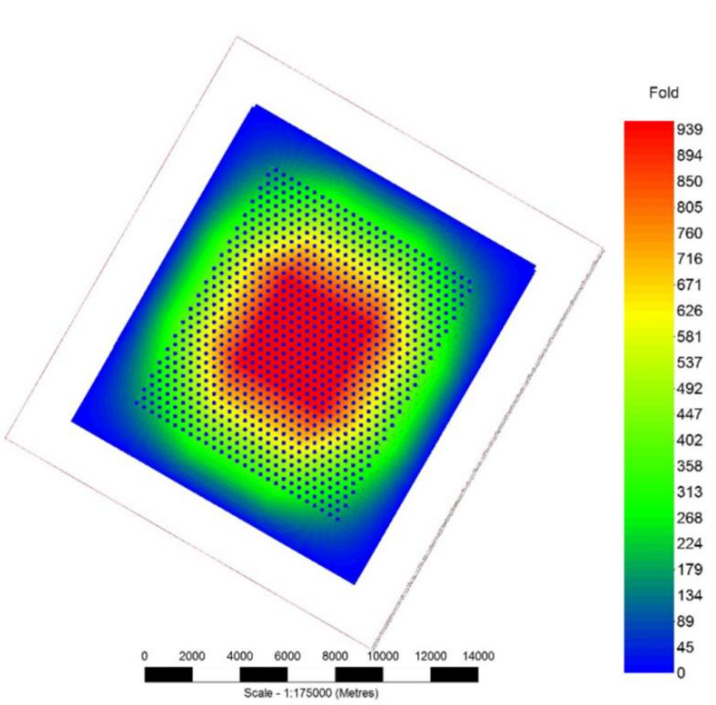
# What is in the tool box?

- Torch Light = sound wave
- Looking from different directions = full azimuth data
- From different distances = Full offset data
- White light = Broadband sound
- Seeing past the obstrucion = 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?

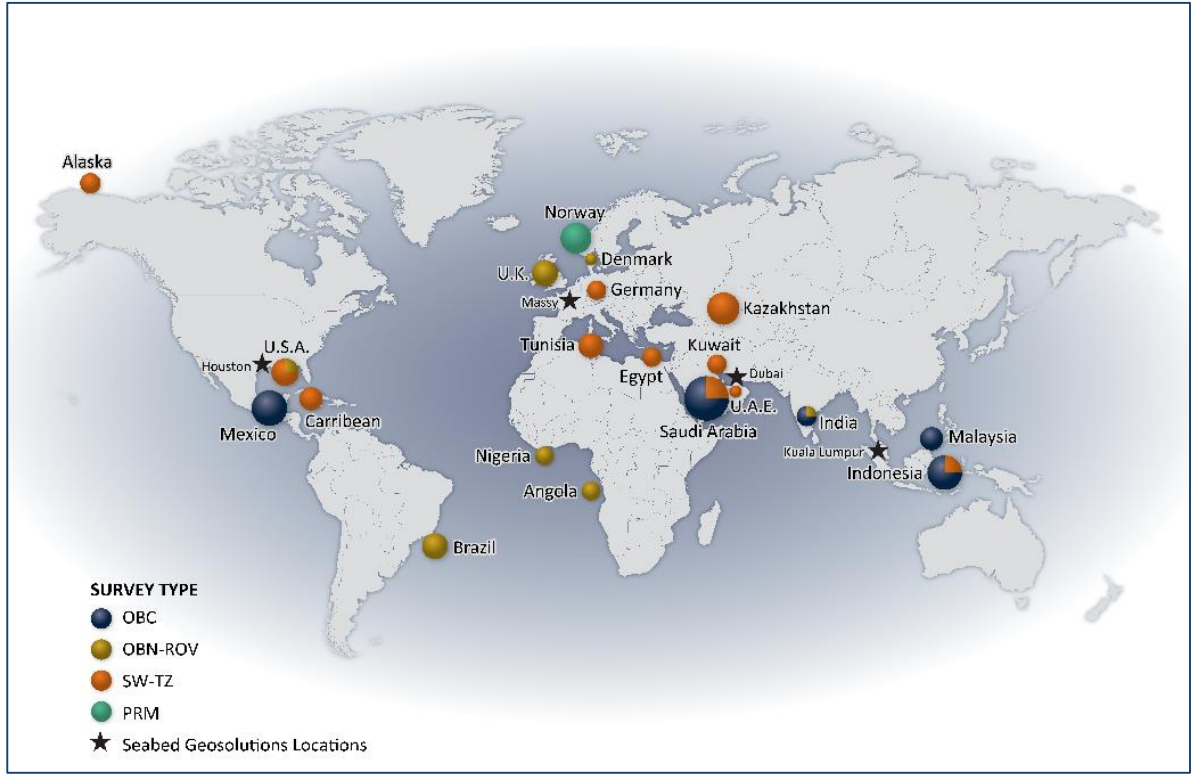


# What Does Seabed Geosolutions Deliver?

- 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

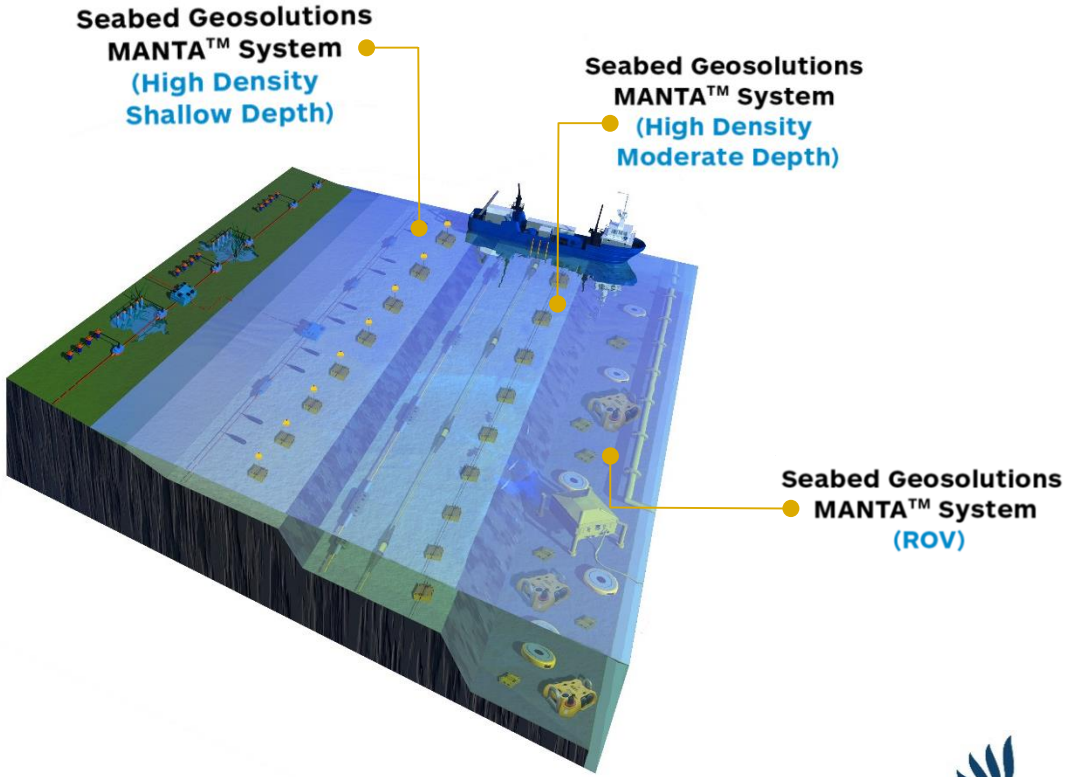
# Global Experience

- Extensive global expertise with more than 25,000 km$^2$ of seismic data collected since 2005

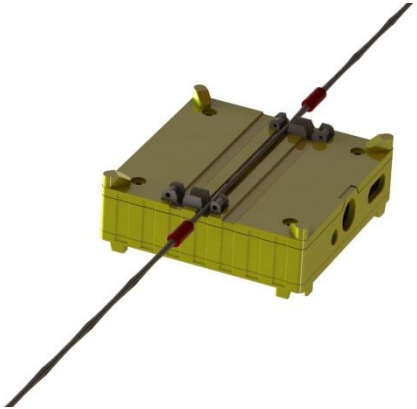


# Operating Environments

- 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

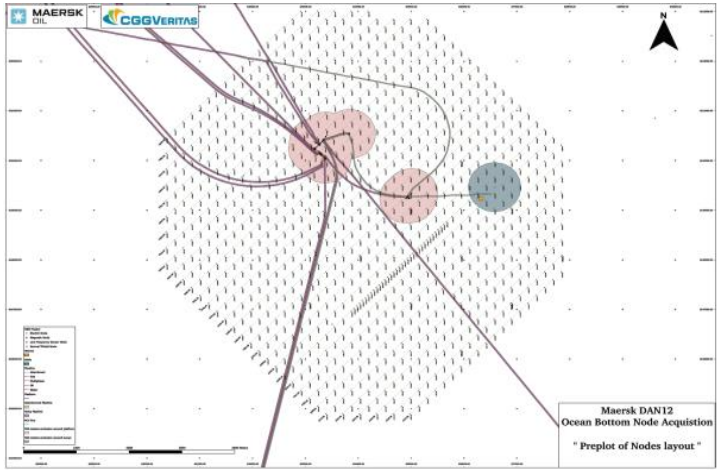
# What about in the real world?

Seabed GEOSOLUTIONS

# Dan Field - North Sea Danish sector

- Chalk reservoir
- Complex structure
- Water injection

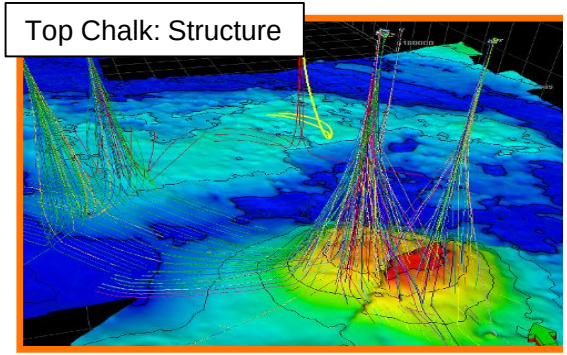
- 225m node interval
- 37.5m shot interval

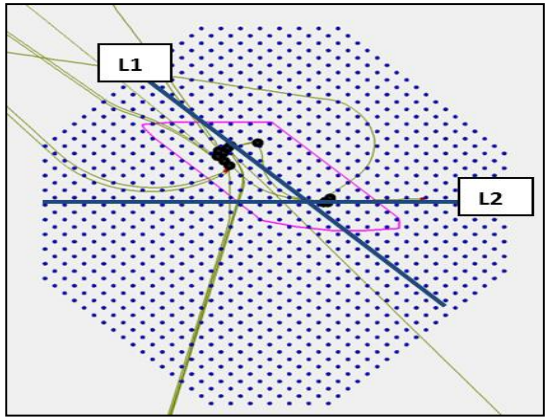



- Streamer baseline survey
- 2012 4D monitoring survey: combined streamers and nodes

# Dan Field

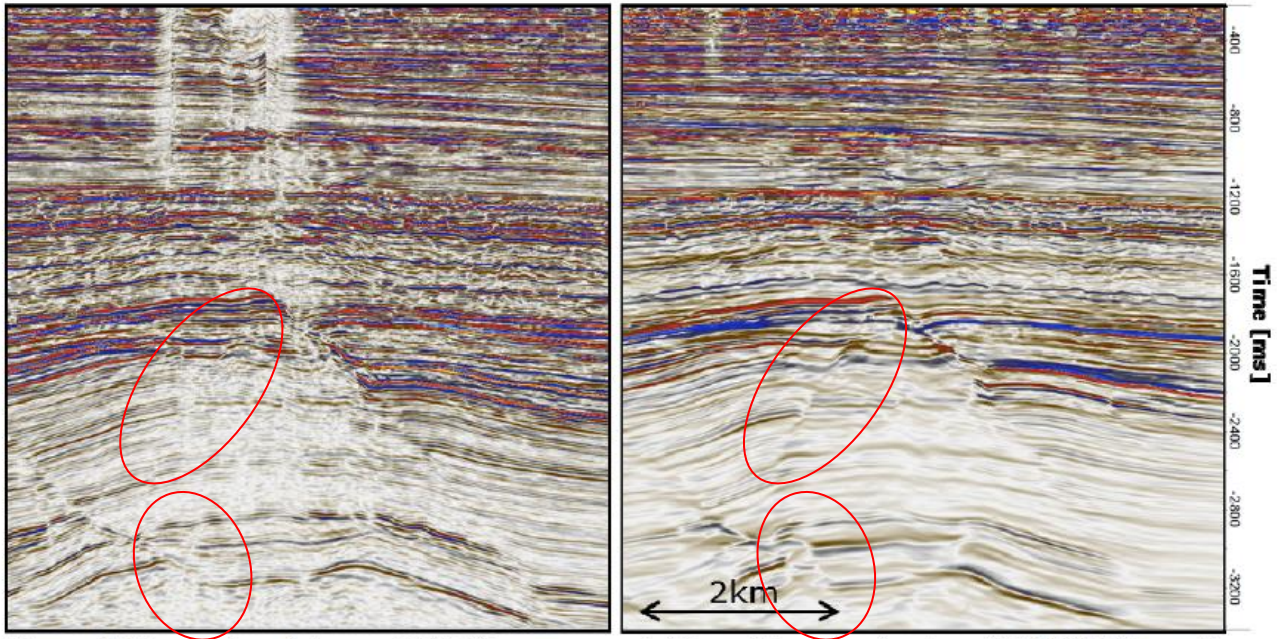
Top Chalk: Structure






- 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

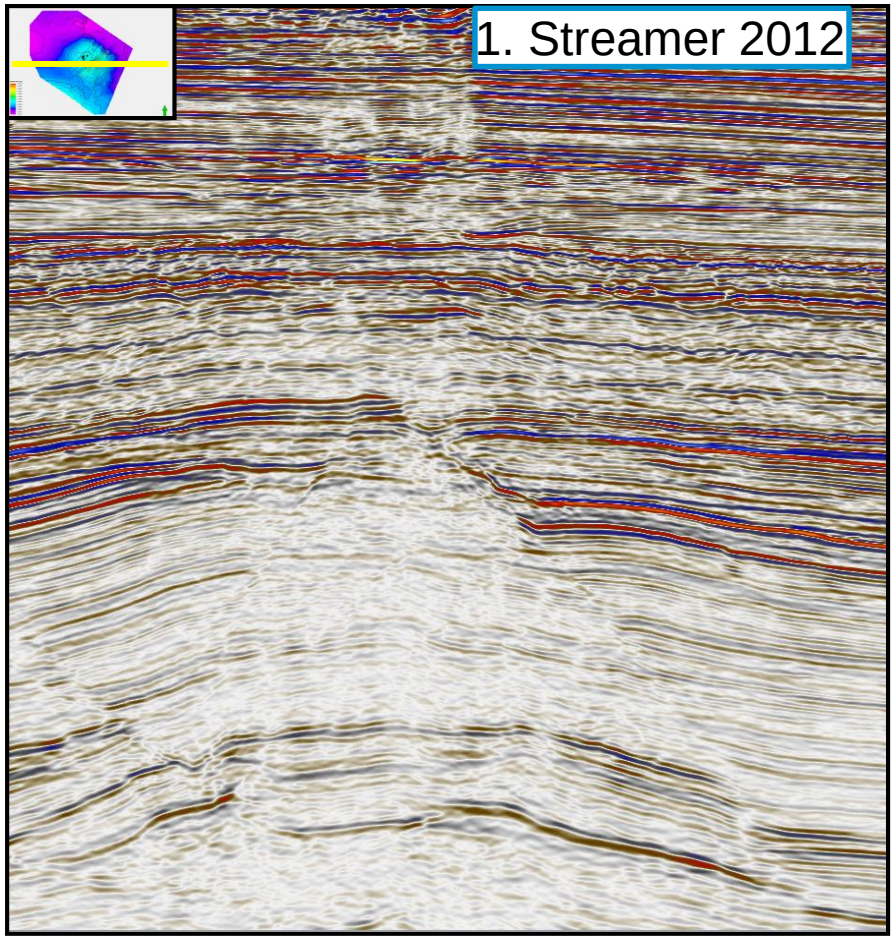
# Streamer to OBS comparison - Maersk Dan Field

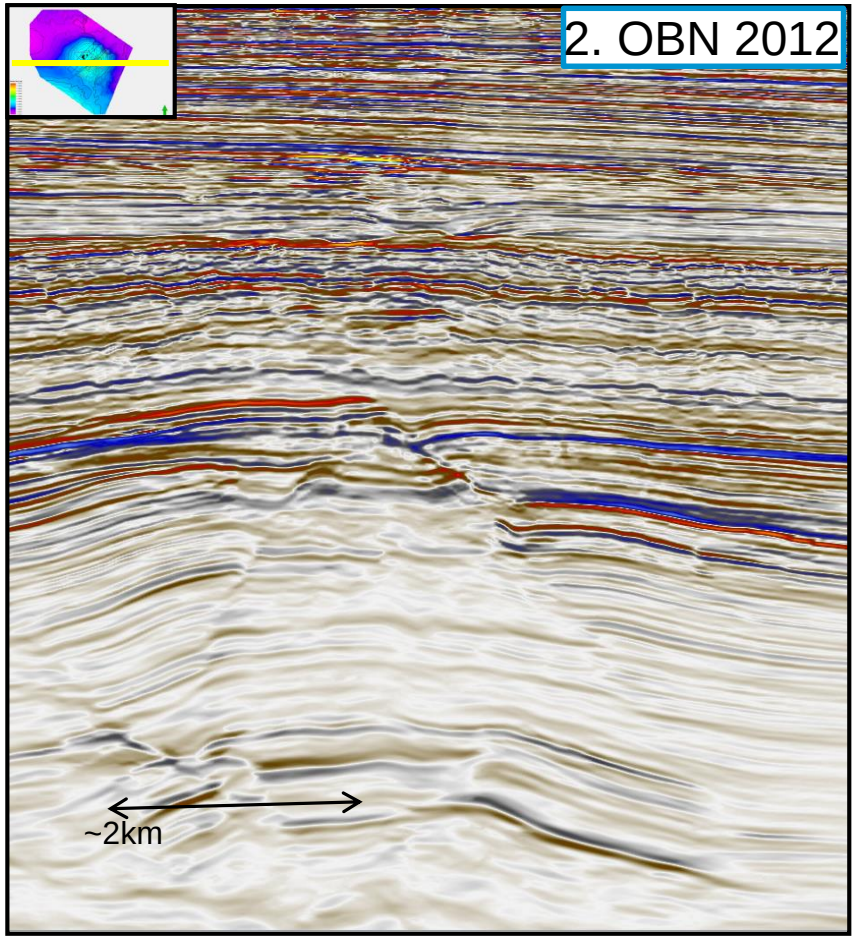



*Images courtesy of Maersk*

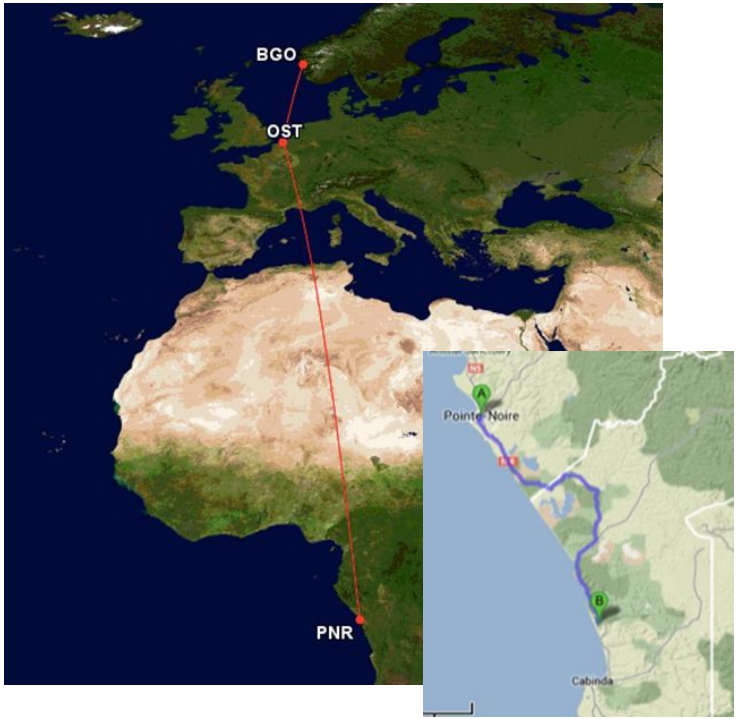
2012 Streamer with infill

Ocean Bottom Seismic


1. Streamer 2012

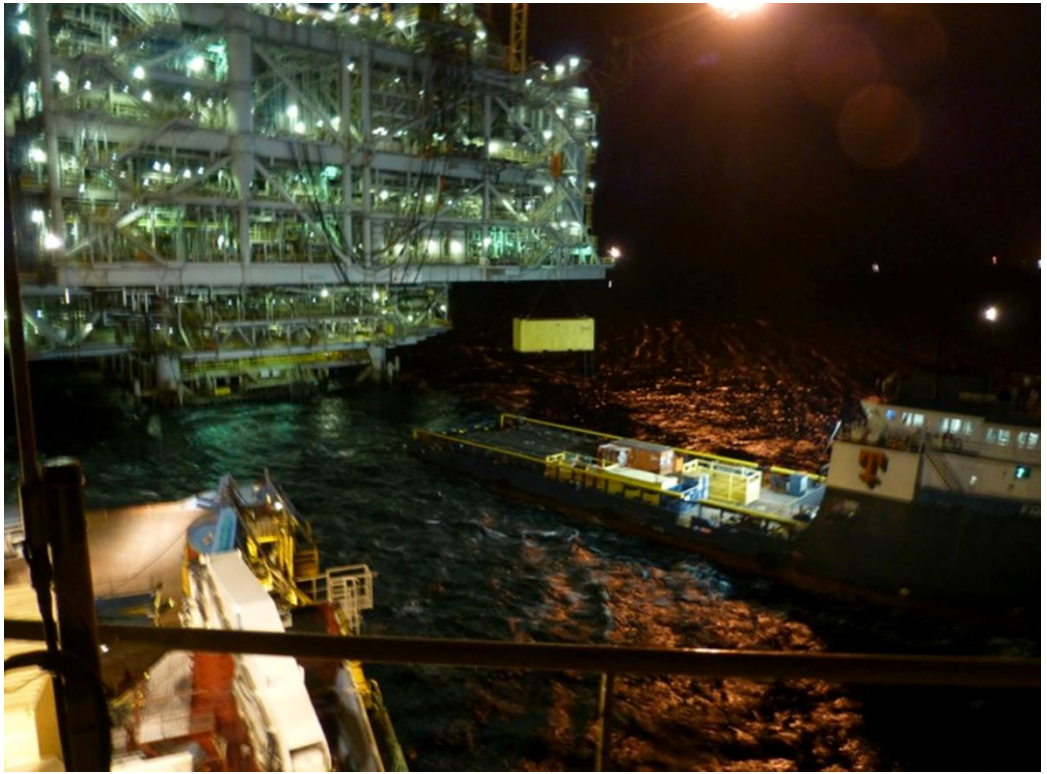

2. OBN 2012
~2km

# 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

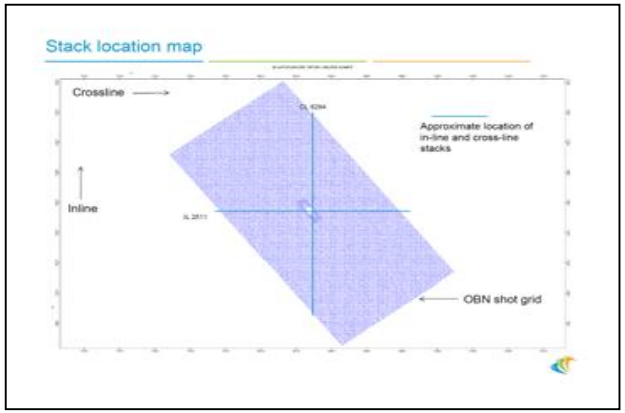
# Platform Crane from the PSV

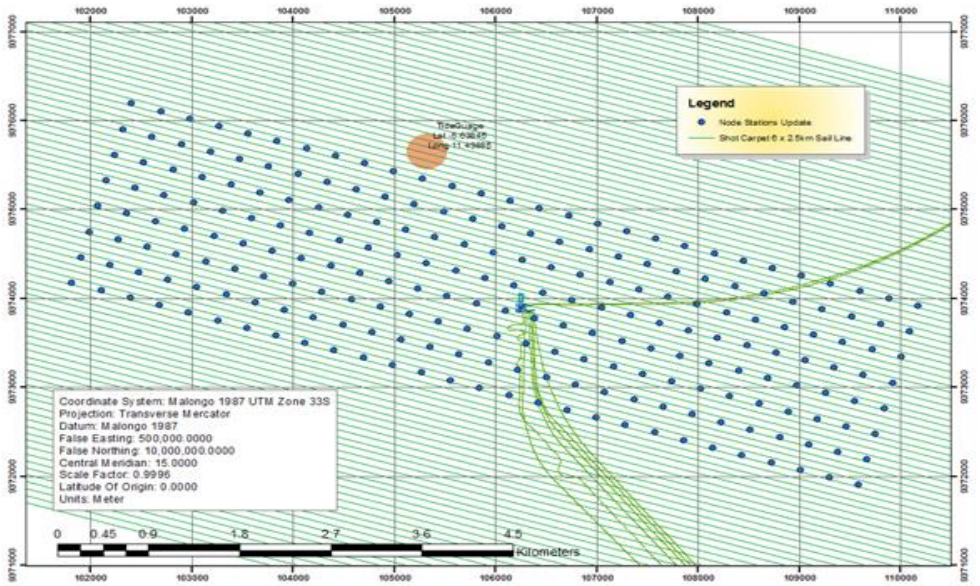


# Nodes and Crew in Containers

# ROV Skid and Node Handling


# TL Platform Undershoot

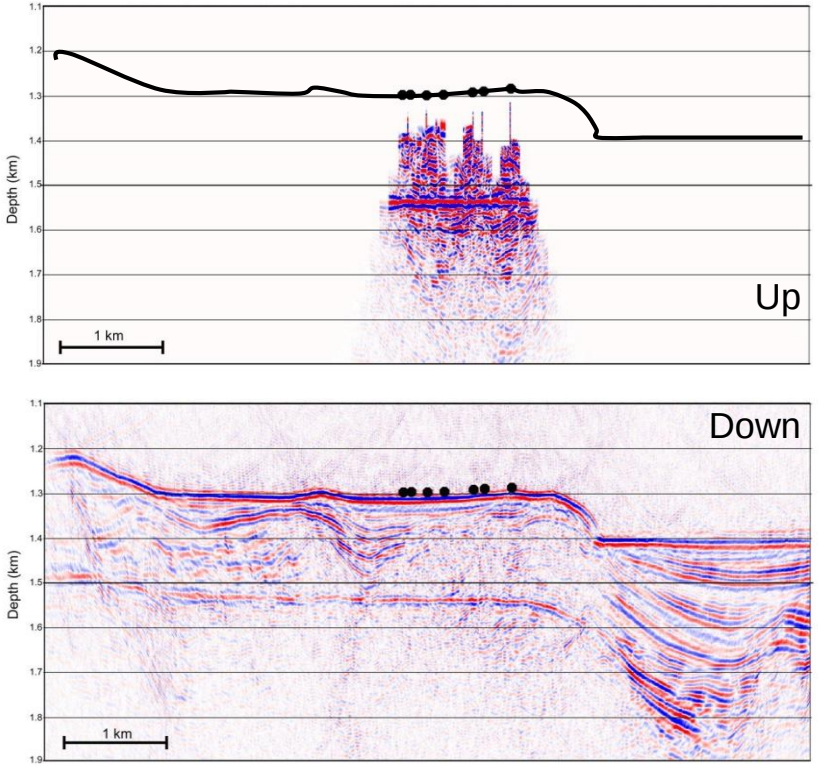



Rx distance: 300 m
Sx distance: 37.5 m
Min in-line offset: 2.5 km
Min x-line offset : 2.5 km

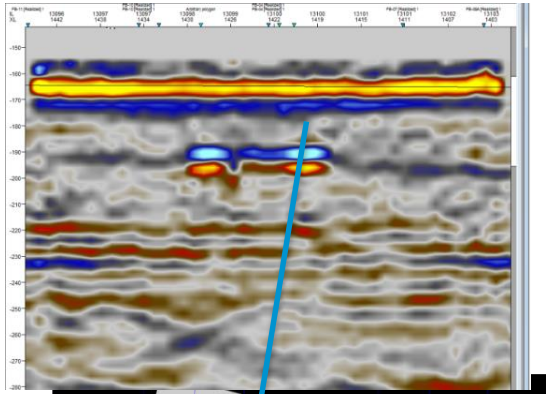
WD 320-440 m

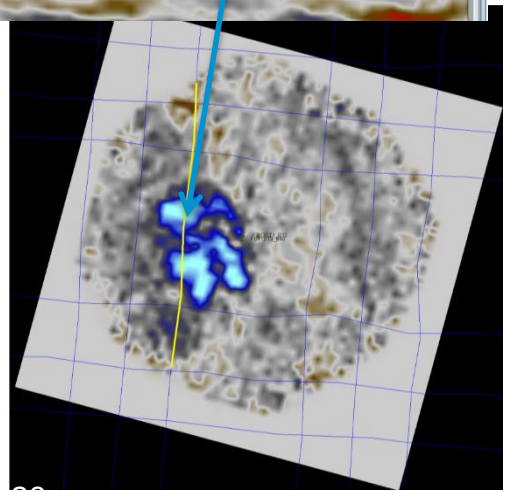
# Remember the mirrors



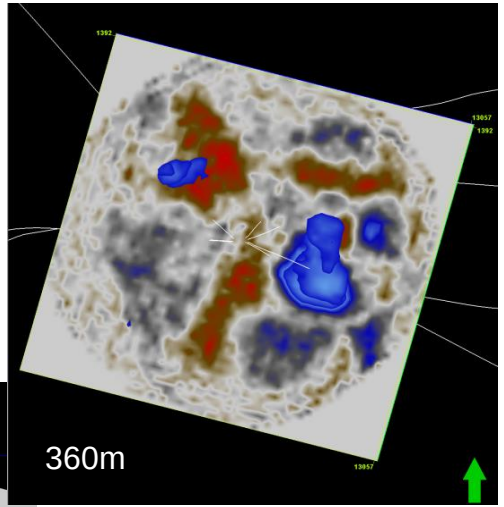

Dash et al, 2009

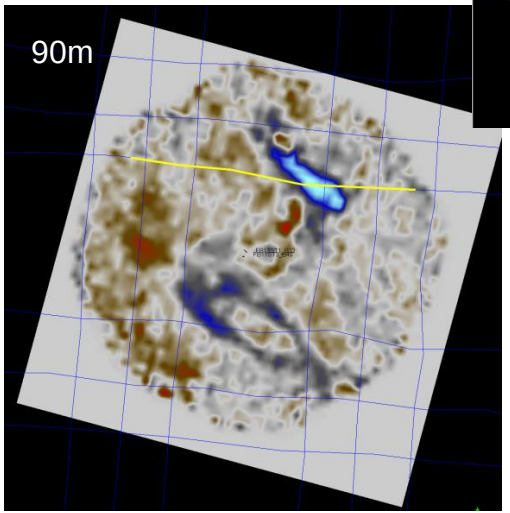
# Avoiding the jelly fish

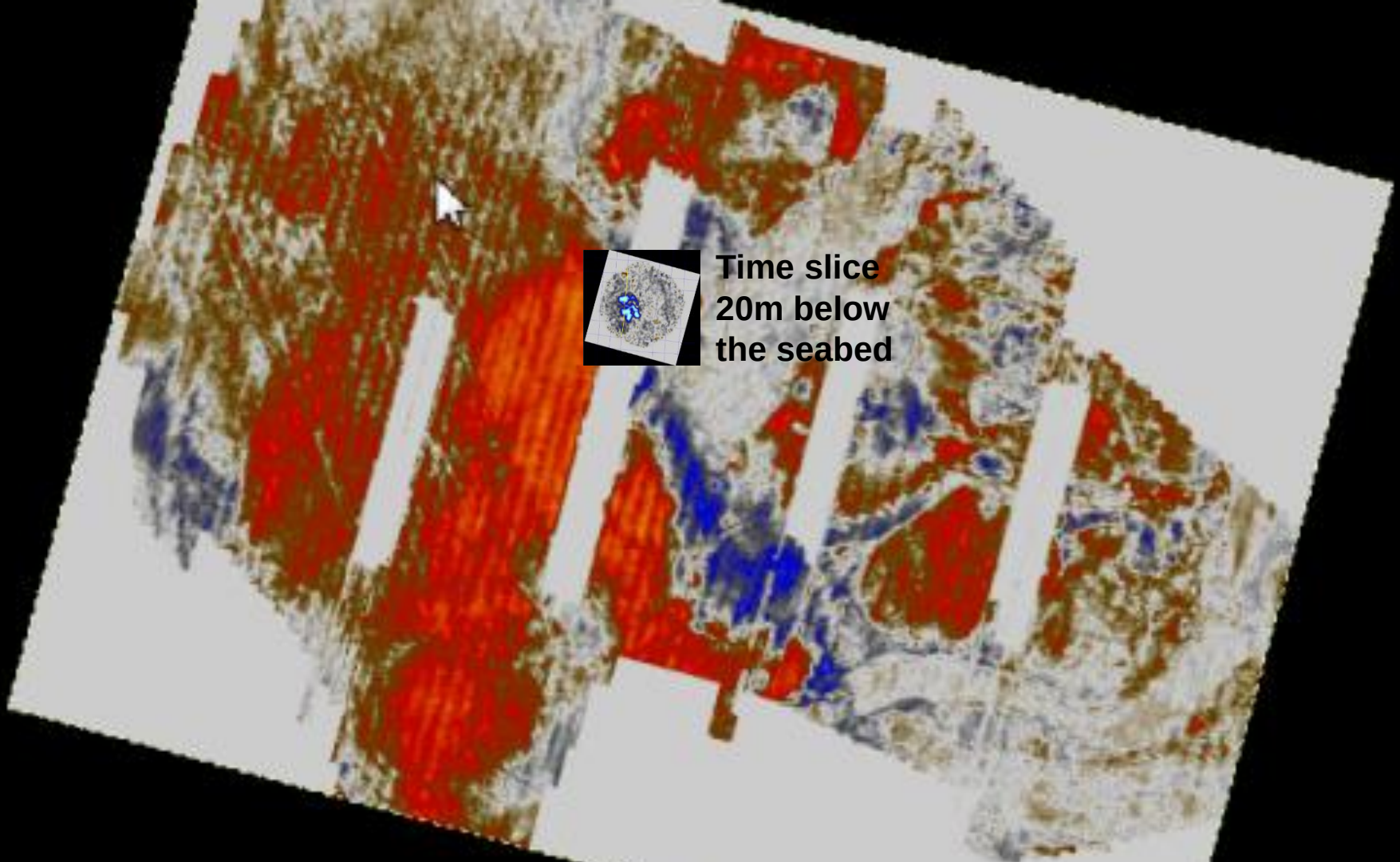




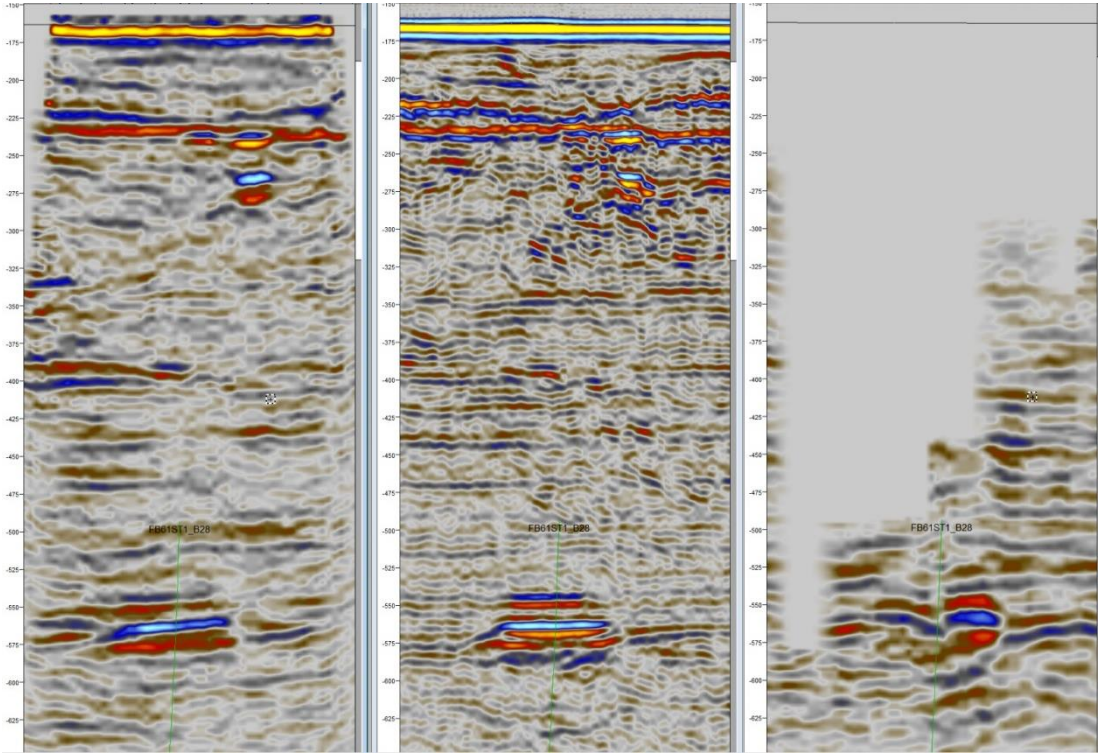
Down-going OBS data provides 3D image of hazards below platform as shallow as 20m below seabed




Time slice
20m below
the seabed

Nodes 3D Streamer 2D 3D Streamer Undershoot



# The Jacuzzi conundrum

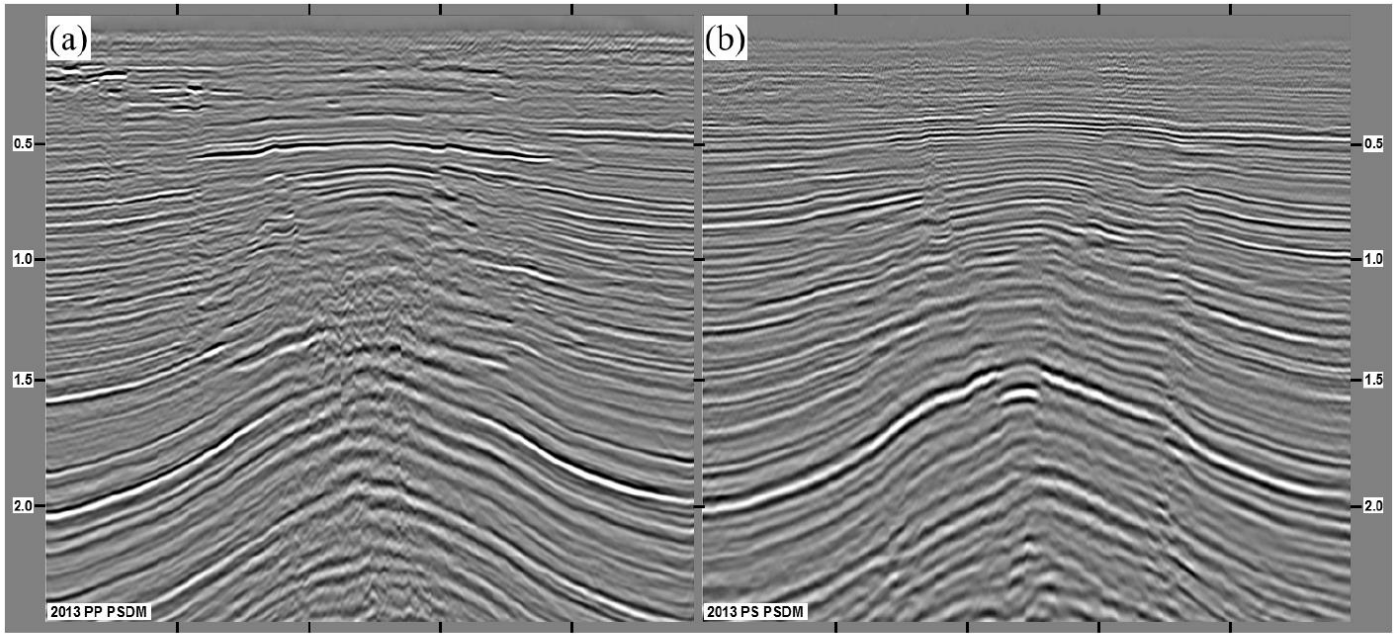
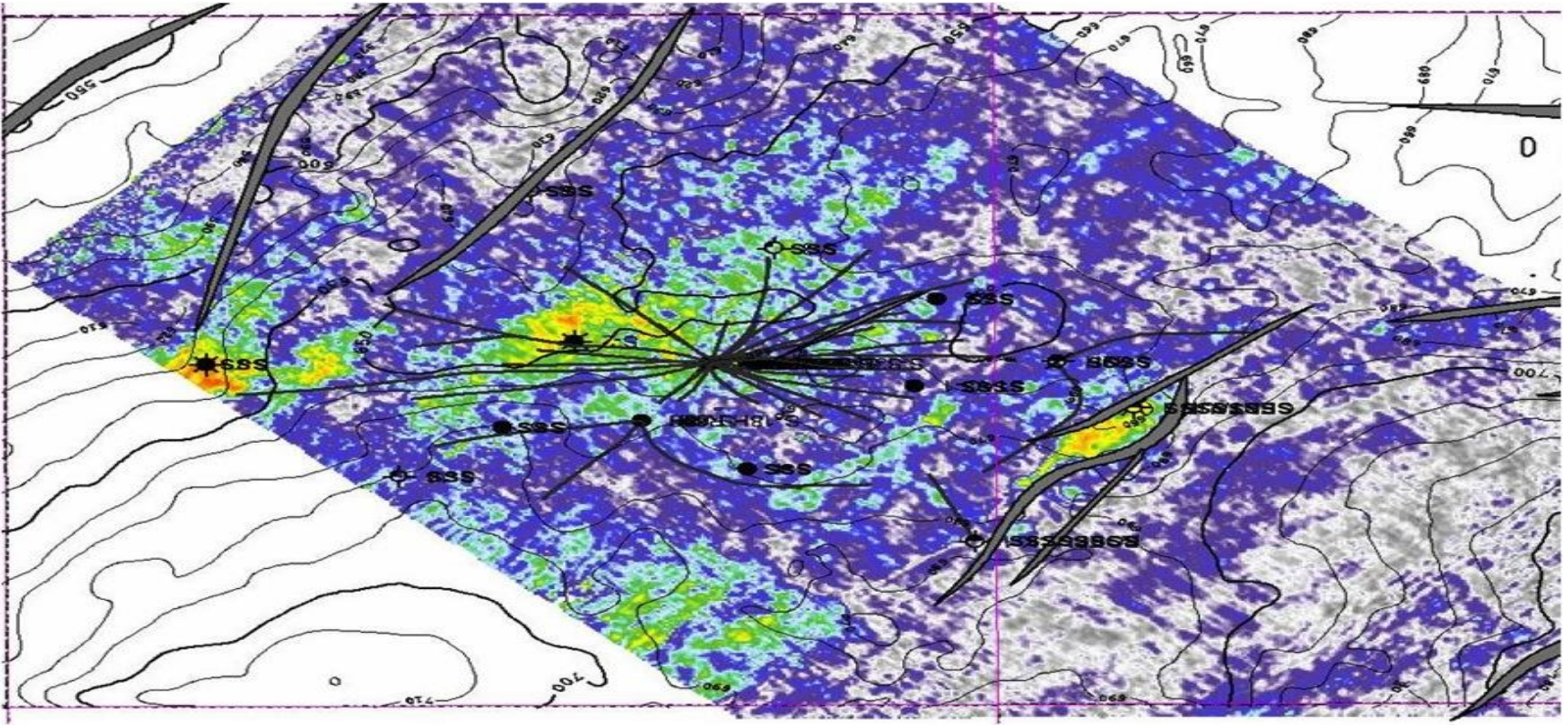



***Figure 6*** *Comparison of PP-PSDM and PS-PSDM stacks in depth domain.*

EAGE 2014: Acknowledgement PETRONAS and PETRONAS Carigali Sdn. Bh

# Streamer data

Data Courtesy of Apache



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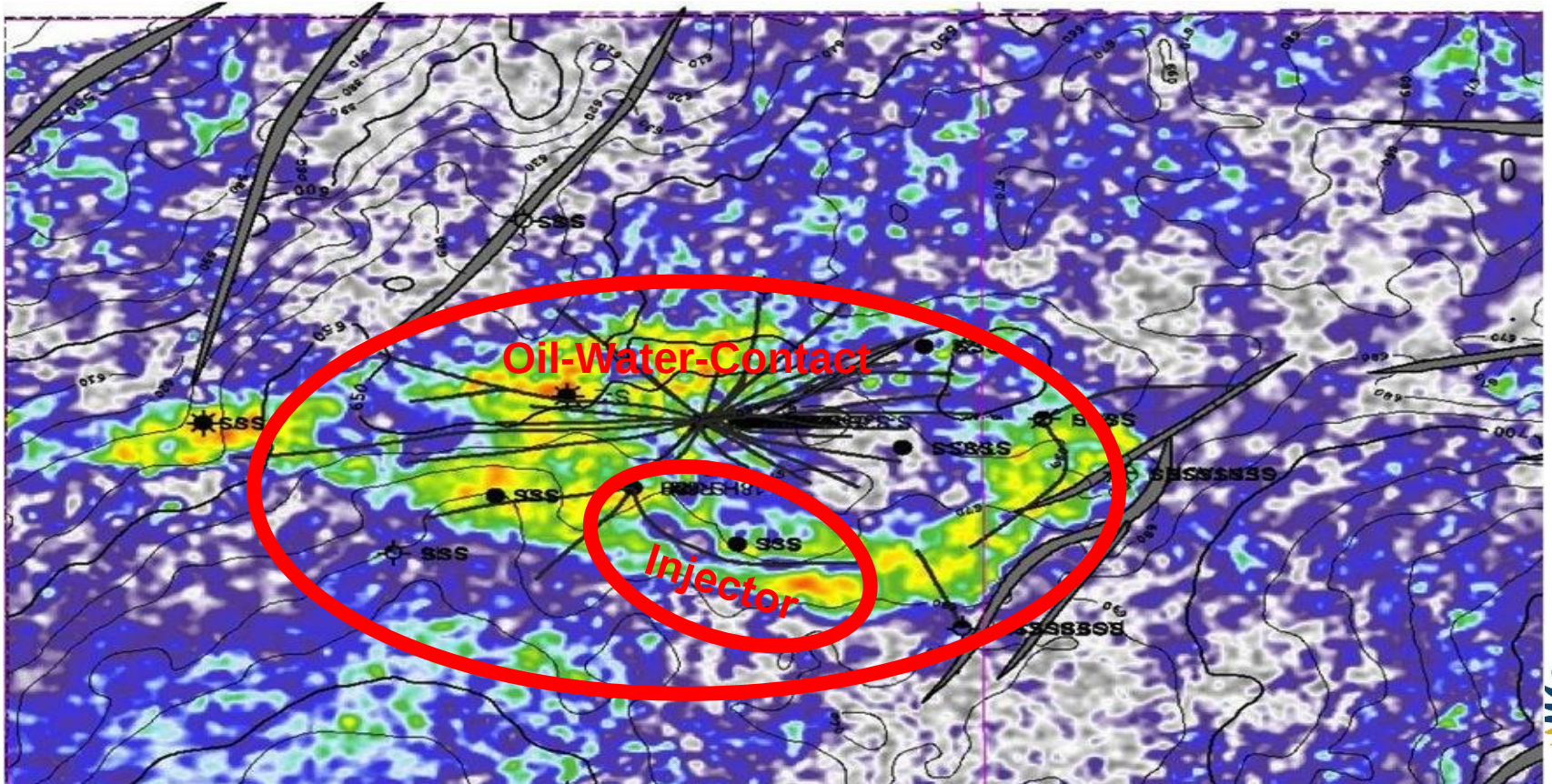


# Value of Information



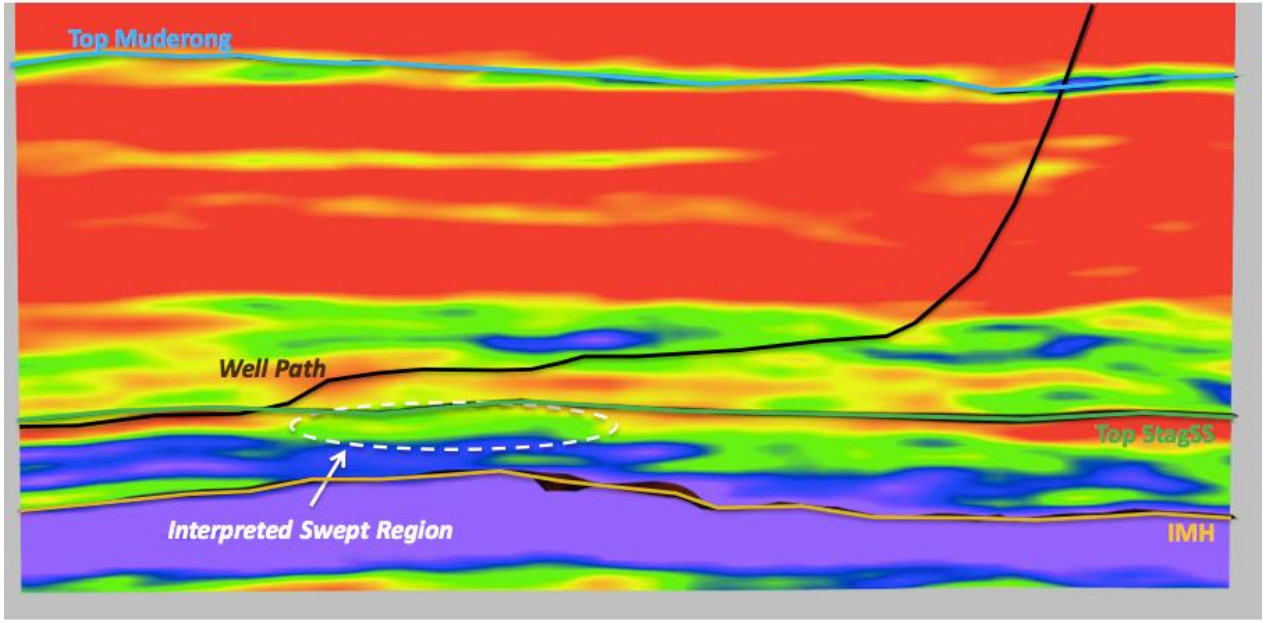
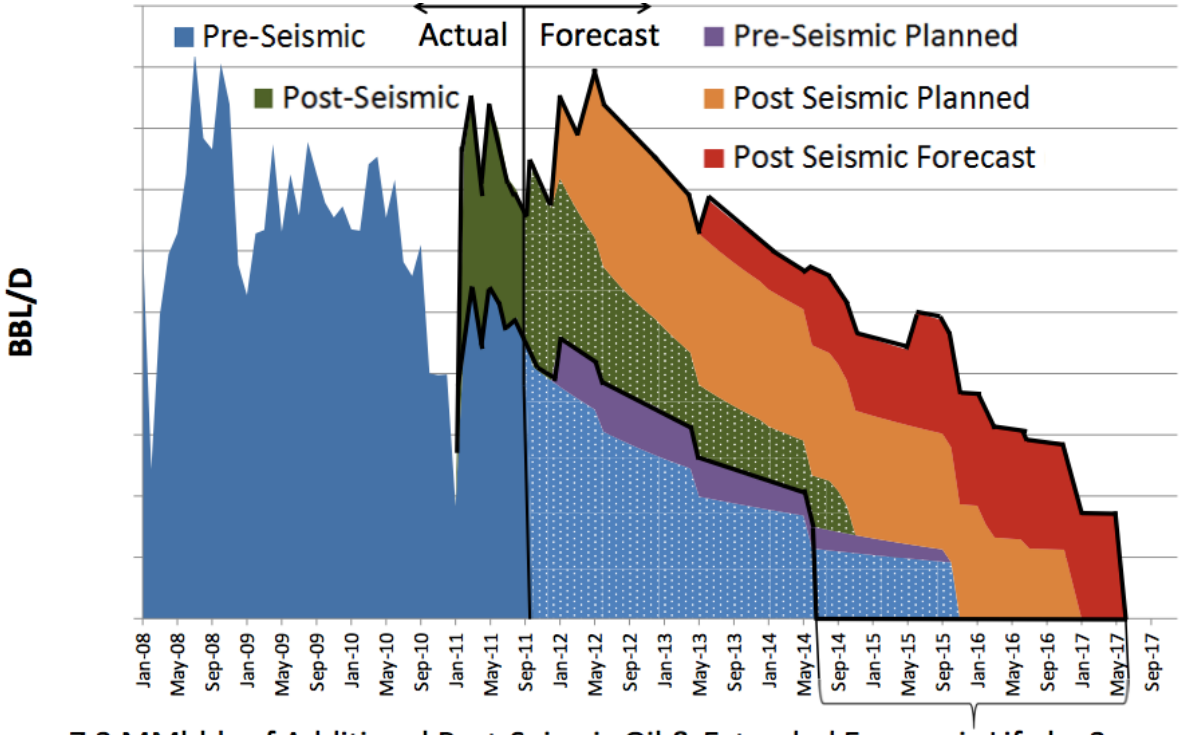



Figure 7 – Production well P-1 actual path shown on P-Impedance cross-section from joint multicomponent inversion. Region highlighted in ellipse has been interpreted to

# Value of Information

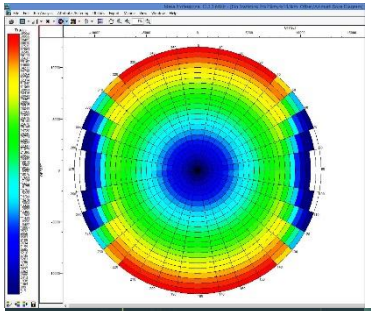


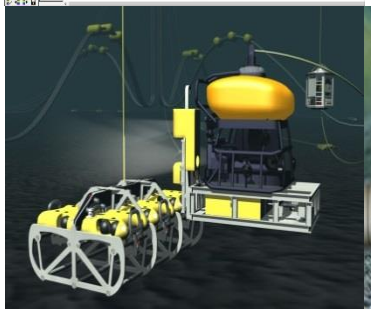



7.3 MMbbls of Additional Post-Seismic Oil & Extended Economic Life by 3 years

# Summary

- Ocean bottom seismic offers the best possible geophysical image
- Unparalleled imaging around and under obstructions
- The huge potential for petrophysical using ocean bottom data analysis is just starting to be uncovered.
- 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