

Shallow Hazards

Fagdag brønnkontroll 2025

19th of February 2025

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Shallow Hazard Events on the NCS

- Still a challenge in 2025? YES
- Why?
 - Hazard not detected – very common with SWF
 - Hazard underestimated - e.g. during pilot hole drilling
 - Unexpected combination of problems
- Can we do something about it? YES

Main Challenge

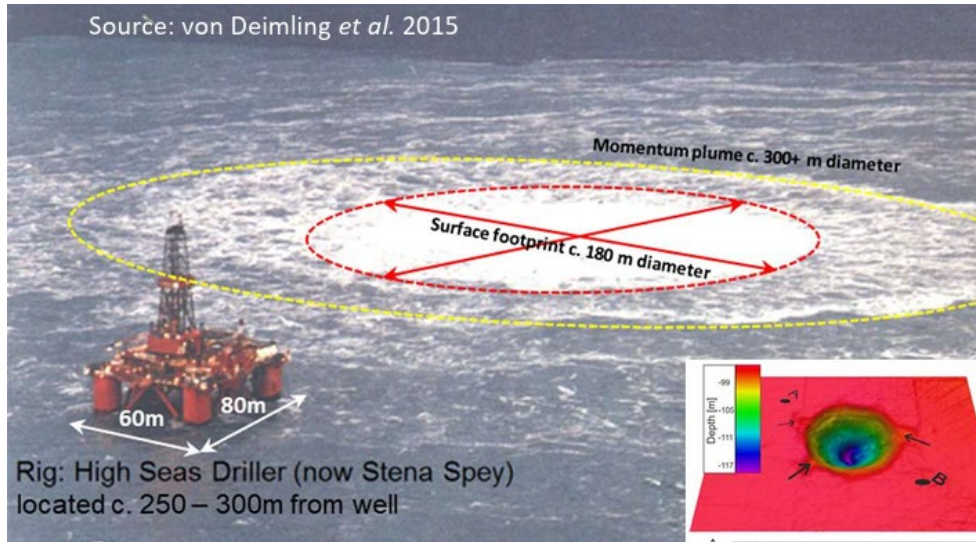
Geohazard		Geohazard
Weak Surface Soils. Cratering during jetting, erosion / mining of soils, fracturing, well-bore deformation.		Boulders. Conductor refusal / deflection
Hard Layers. Low RoP, BHA deflection, stuck pipe, casing hang-up.		Loose sands. Well-bore stability, wash-out, zonal isolation
Reactive Clays. Pack-off, gumbo, loss of drilled annulus.		Buried Channels (Gravel lag deposits, hard layers). Conductor refusal, losses, zonal isolation
Excess Pore Water Pressure. Low shear strength, inability to cement annulus.		Highly structured clays. Horizontal and vertical fractures, reduced fracture pressure, foundation integrity
Buried landslides (MTC's). Directional drilling issues, stuck pipe, casing hang-up		Gas Hydrates. Gas seepage to seafloor, shallow gas trap. Potential destabilisation
Shallow Water Flow. Pressure kicks, problems cementing casing, loss of integrity, formation fracture, casing collapse, permeable zone isolation, loss of well.		Faults. Losses, BHA deflection, stuck pipe/twist off, casing hang-up, broach pathway to seafloor, pressure communication to depth
Shallow Gas (Free Gas). Pressure kicks, Blow-out, loss of well, loss of rig, environmental release.		Drilling Related Issues:
Shallow Oil. Uncontrolled flow to seafloor, environmental release.		• High rate of progress • High ECD, pack-off • High flow rate, wash-out, poorly cemented annulus, variable gauge hole, soil swelling • Drilling Blind. No, or partial returns, hydraulic fracture, reduction of soil strength. • Use of dispersants. Mining and swelling. • Use of drilling mud. Water based vs synthetic, reactive clays, environmental concerns
Formation Gas (In solution). Inability to cement annulus, pressure build up at wellhead, well integrity issues.		
Building Angle. Inability to steer BHA, multiple attempt at drilling trajectory, reduction of shear strength, fracturing.		

1. Shallow Gas
2. Shallow Water Flow
3. Wellbore Stability & Losses

Or a combination of 1, 2 & 3

- Shallow gas & shallow water flow = shallow pressure problem
- Limited or no well control barriers

Just a reminder



- 22/4b-4 blowout in 1990
- 20 m x 70 m crater
- Still leaking today



- Real life analogue of a heavy gas blowout
- 5 nautical mile safety zone

How to get better in 5 steps

1. Acquire good site survey data
2. High Resolution Processing
3. Integrate ALL subsurface data = IOGP Best Practise
4. Use seismic attributes & AVO
5. Don't forget other Geohazards

Avoid, prepare & mitigate

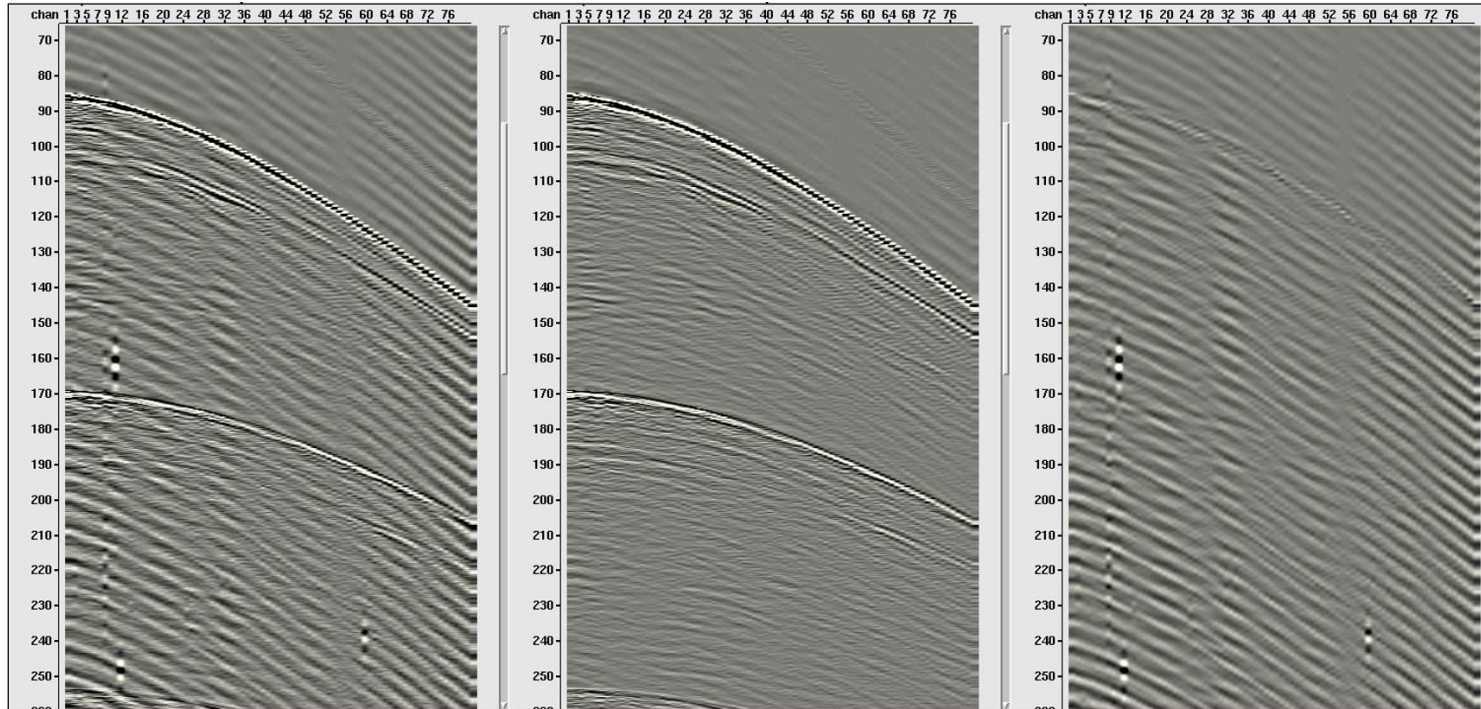
⇒ Avoidance is the cheapest & easiest option

1 - Acquire Good Site Survey Data!

2022 Original Data

After Noise Removal

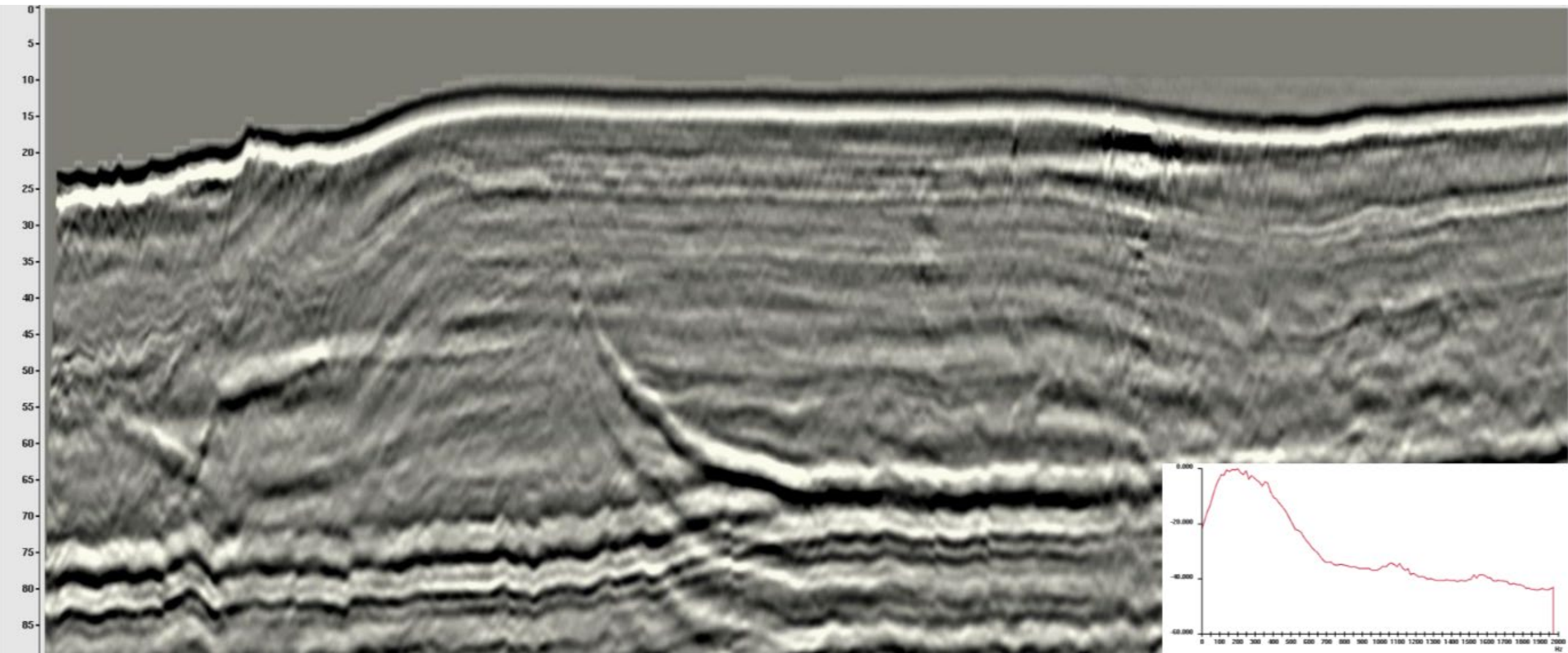
Noise Removed



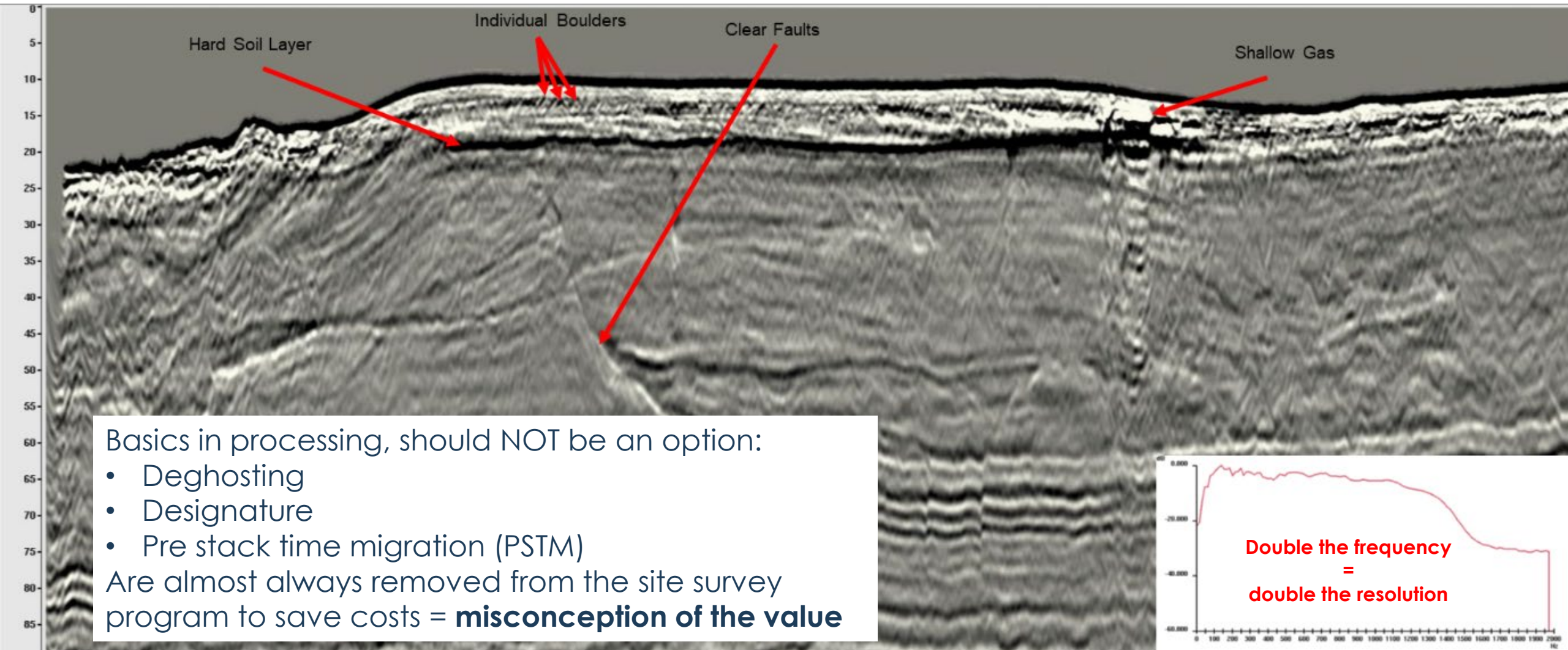
Key Learnings

- Use **experienced Client Reps** to QC quality offshore
- **Process offshore** processing to check the quality during acquisition
- **Avoid bad weather** if you can for geophysical data acquisition – waste of time to collect bad data
- Use **high resolution processing techniques (“Broadband”)**

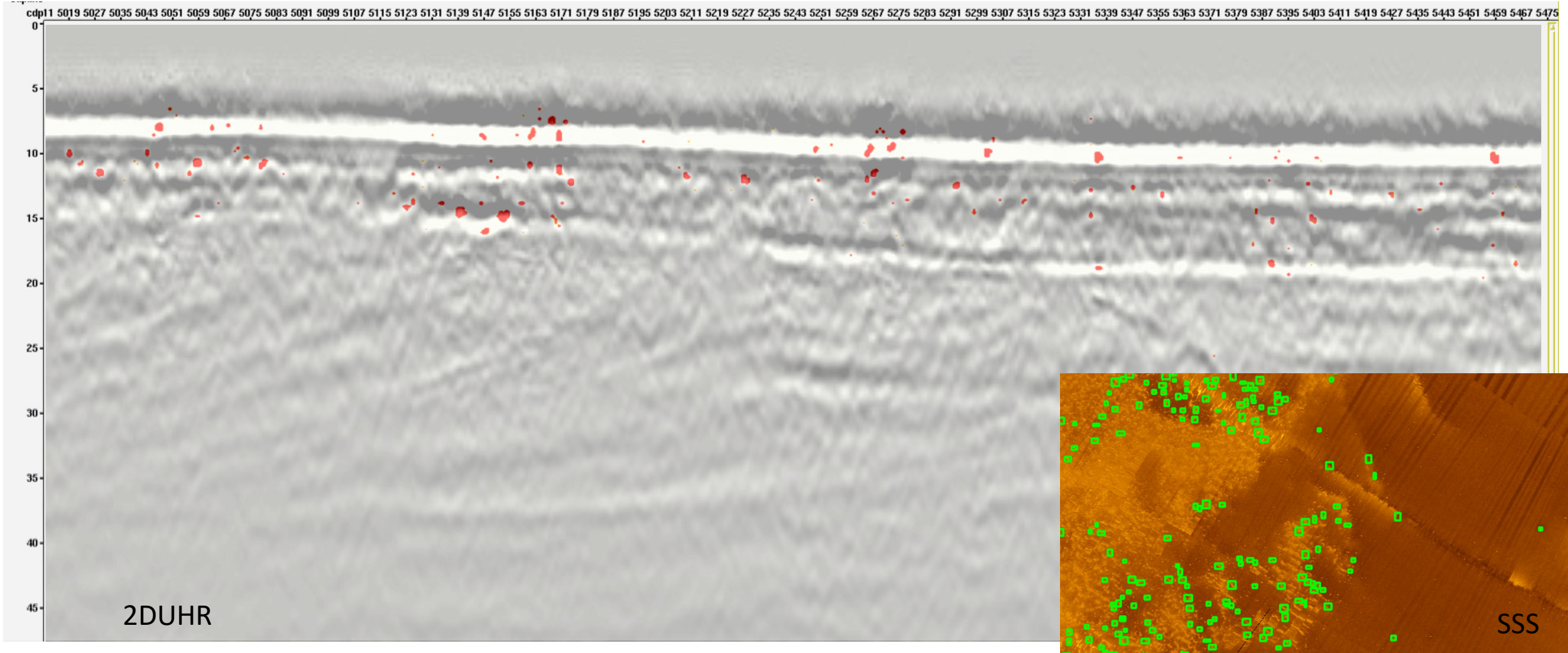
2 -Improve Resolution – Classic Data



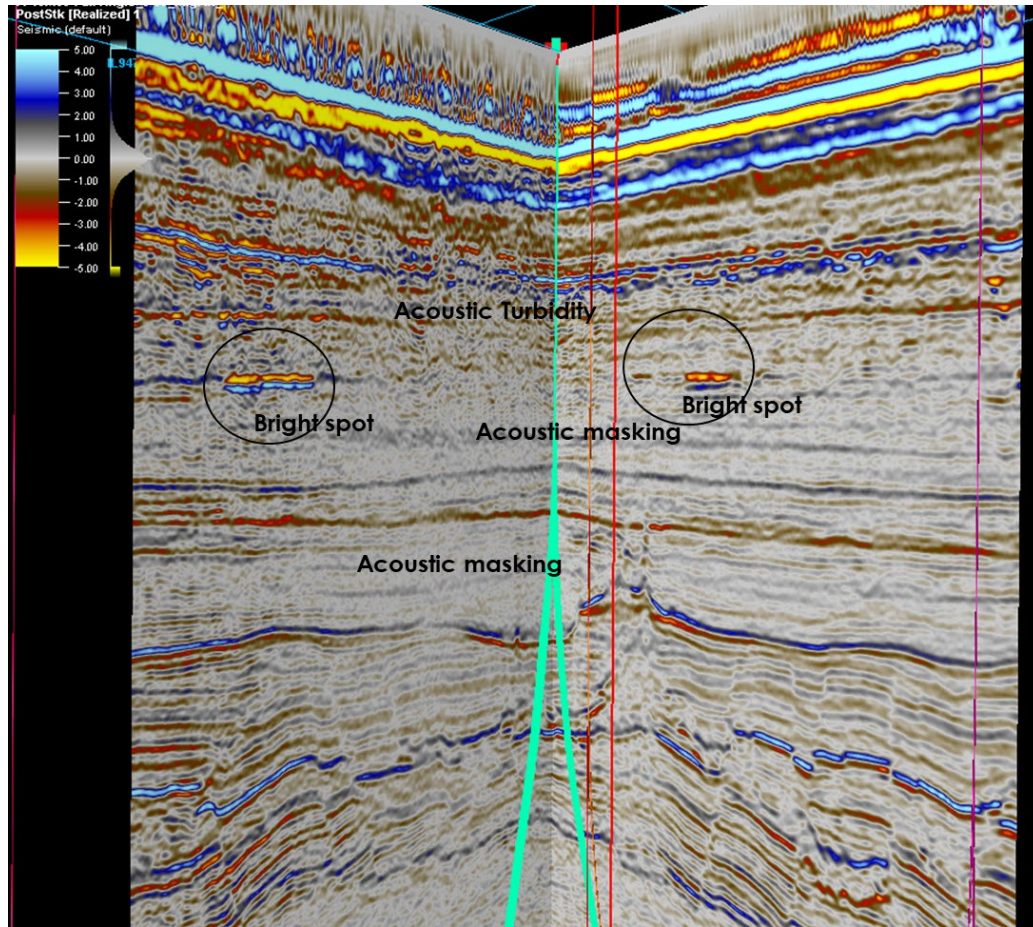
2 - Improve Resolution – Latest Techniques



2 - Bonus = Boulder Detection



3 – Integrate ALL Subsurface Data



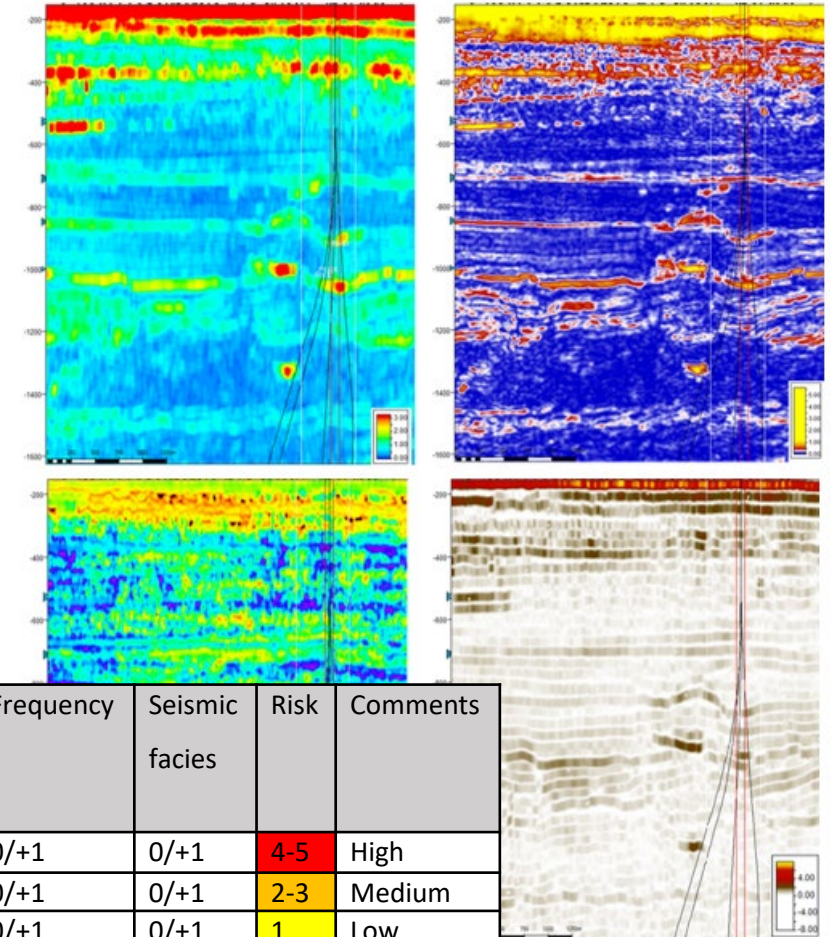
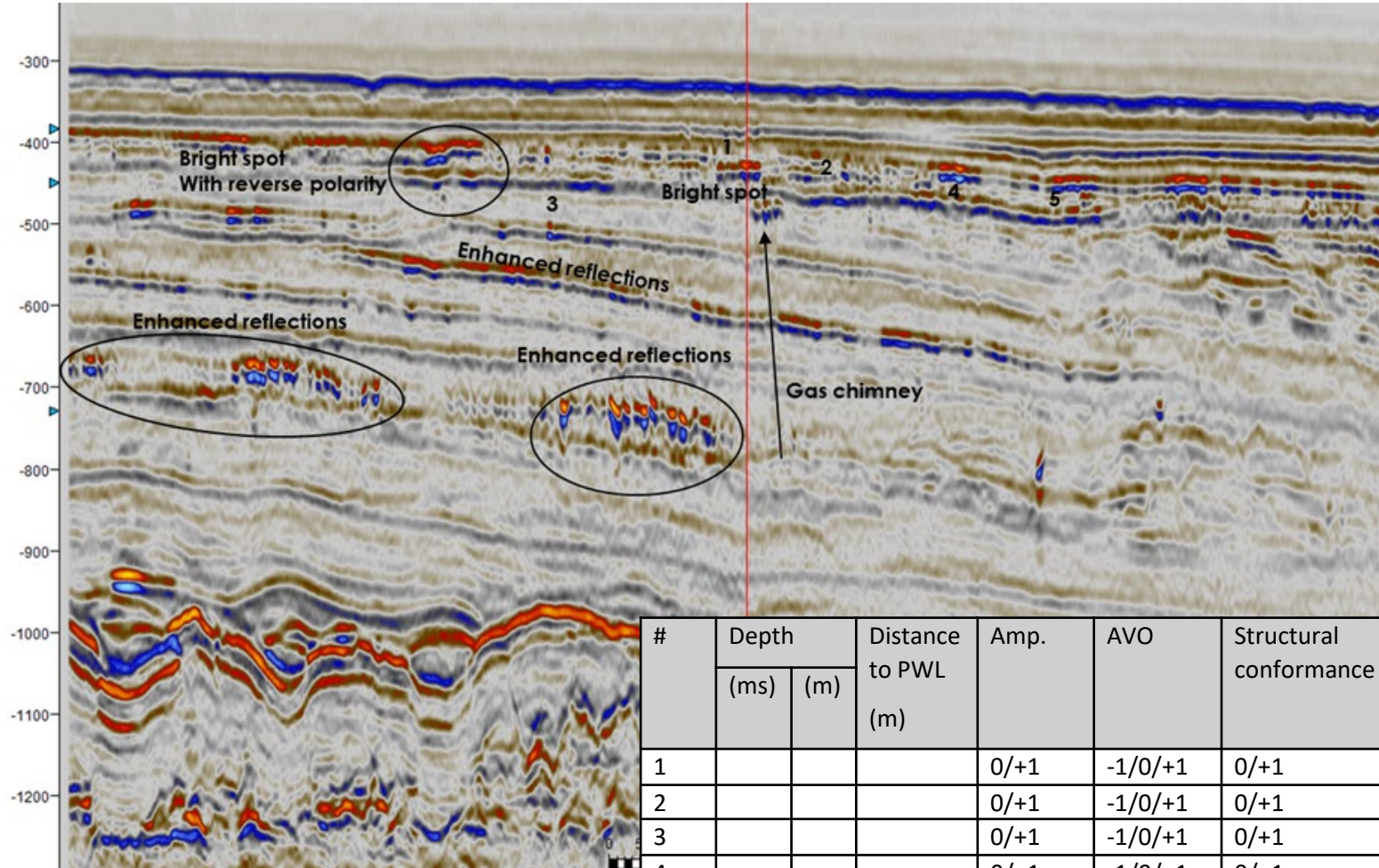
Integrated approach using:

- Multiple datasets
 - 2DUHR & 3D, MBES, SBP
- Seismic attributes
- Velocity data
- Well data and experience

ALL DATA in DEPTH!

High Resolution Velocity data
key to map & detect SWF

4 - Use Seismic Attributes & AVO

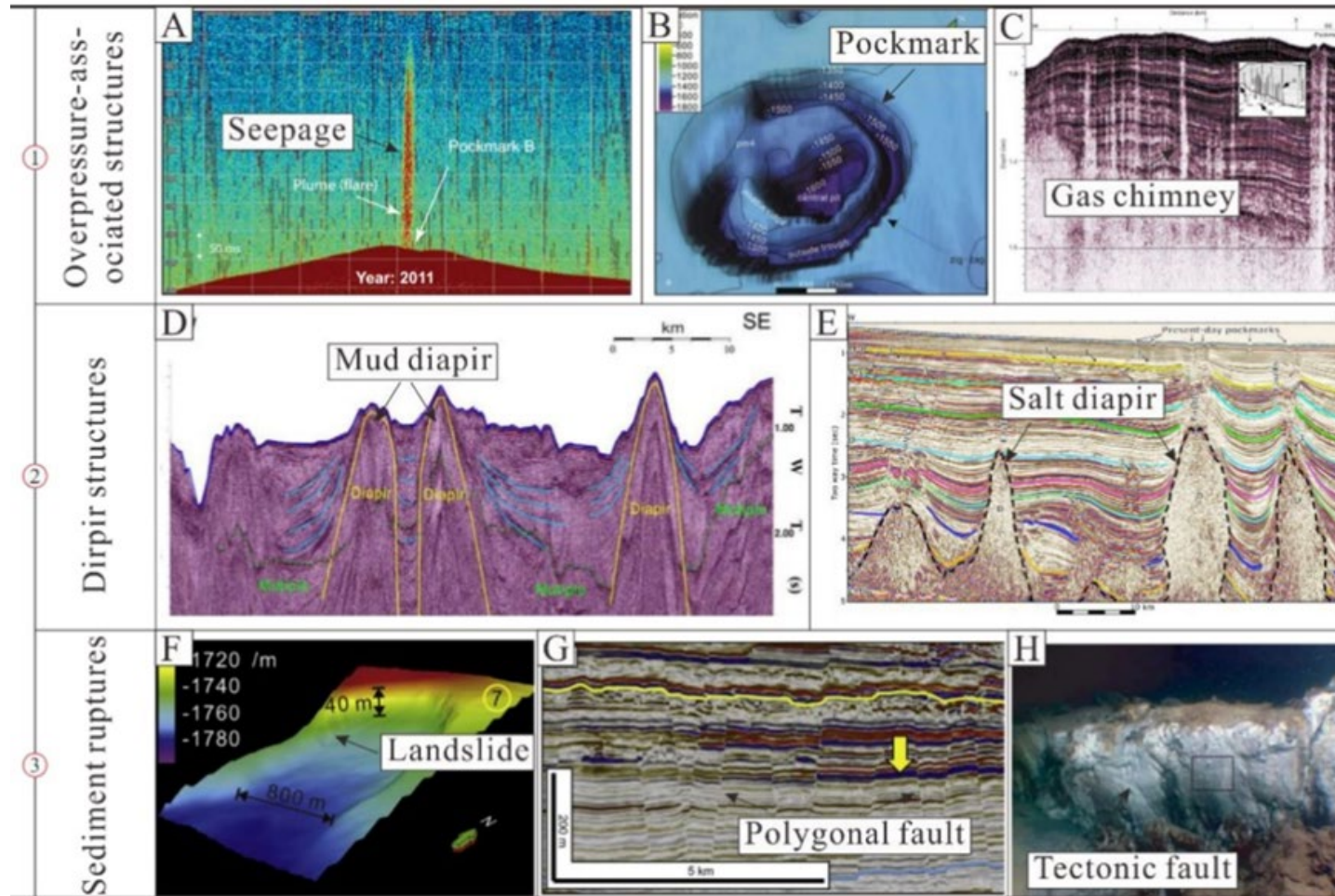


#	Depth		Distance to PWL (m)	Amp.	AVO	Structural conformance	Frequency	Seismic facies	Risk	Comments
	(ms)	(m)								
1				0/+1	-1/0/+1	0/+1	0/+1	0/+1	4-5	High
2				0/+1	-1/0/+1	0/+1	0/+1	0/+1	2-3	Medium
3				0/+1	-1/0/+1	0/+1	0/+1	0/+1	1	Low
4				0/+1	-1/0/+1	0/+1	0/+1	0/+1	0	No Indicators

5 - Other Shallow Hazards

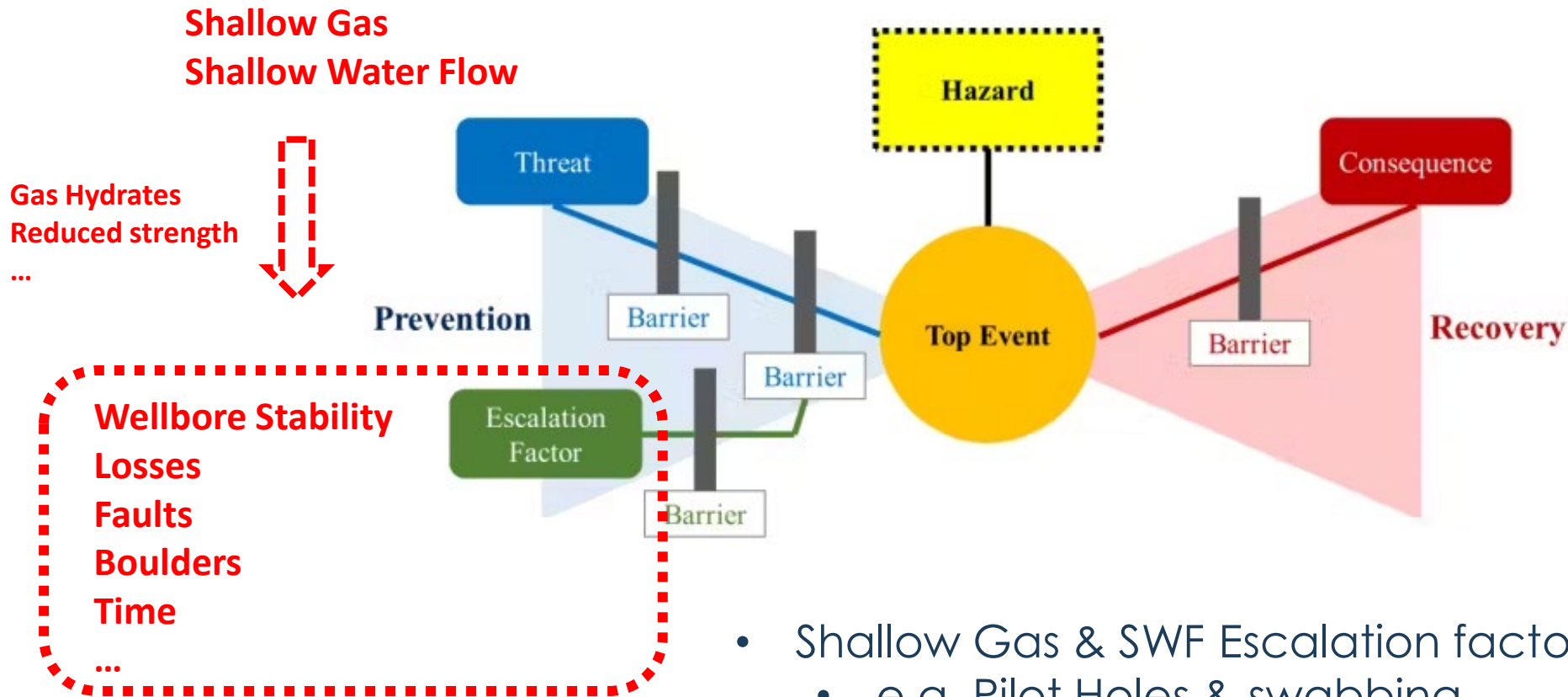
- Lots of different challenges across the Norwegian shelf incl. sand injectites & ooze
- Generally nothing that can't be handled

However



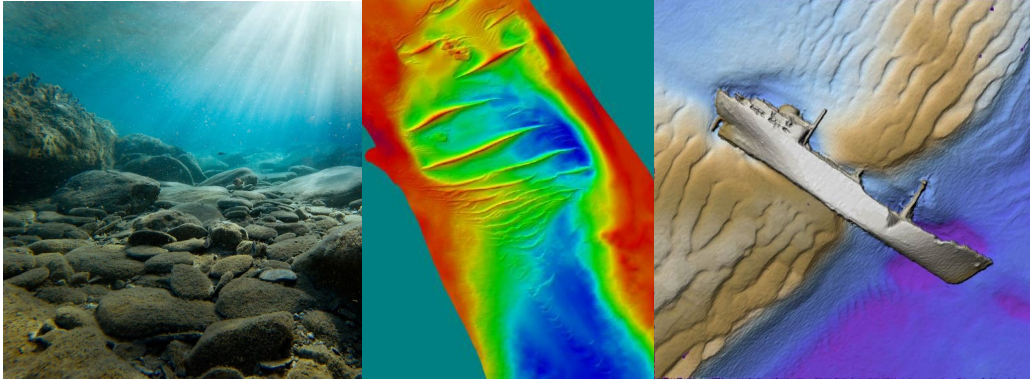
Example from Ma et al., 2021

5 - Other Hazards = Potential Escalation

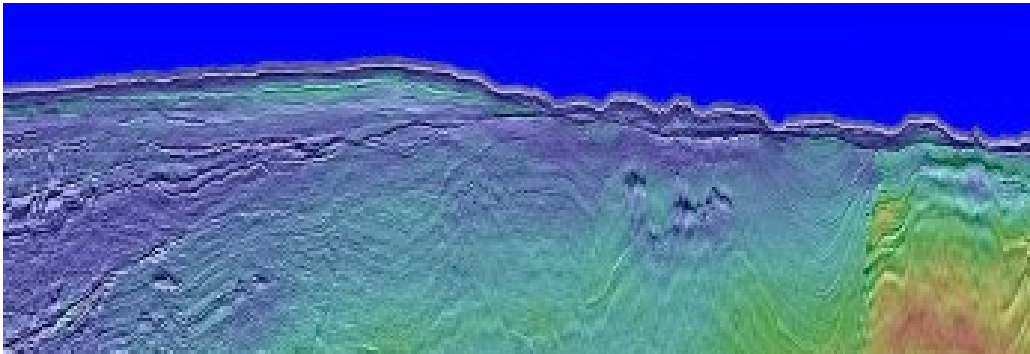


- Shallow Gas & SWF Escalation factors not assessed
 - e.g. Pilot Holes & swabbing
 - Interactions are not considered e.g. gas hydrates
- **Pilot hole or RMR ≠ barrier**

Need a hand?



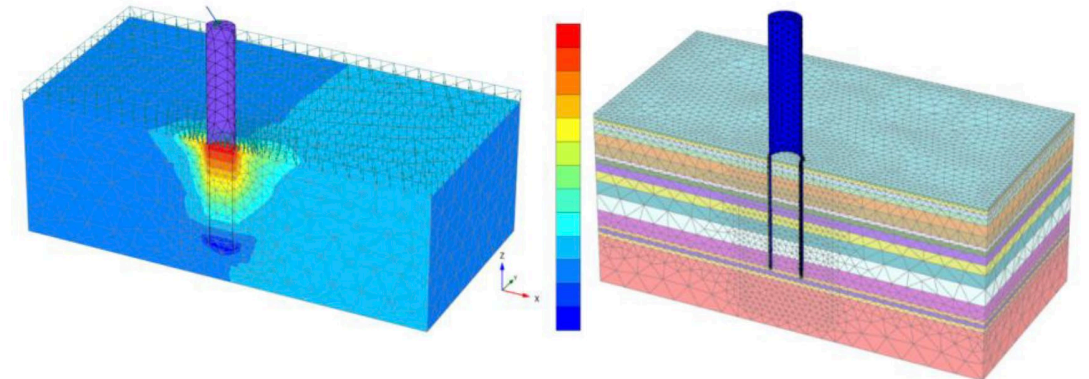
Site Characterisation & Route Studies



High Res Processing & Interpretation



Survey Planning & Operations



SSA Verification & Geotechnical Design