The Ormen Lange Gas Field, Norway
Field Development, From Exploration to Production

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SPE , Moscow March11th,2008

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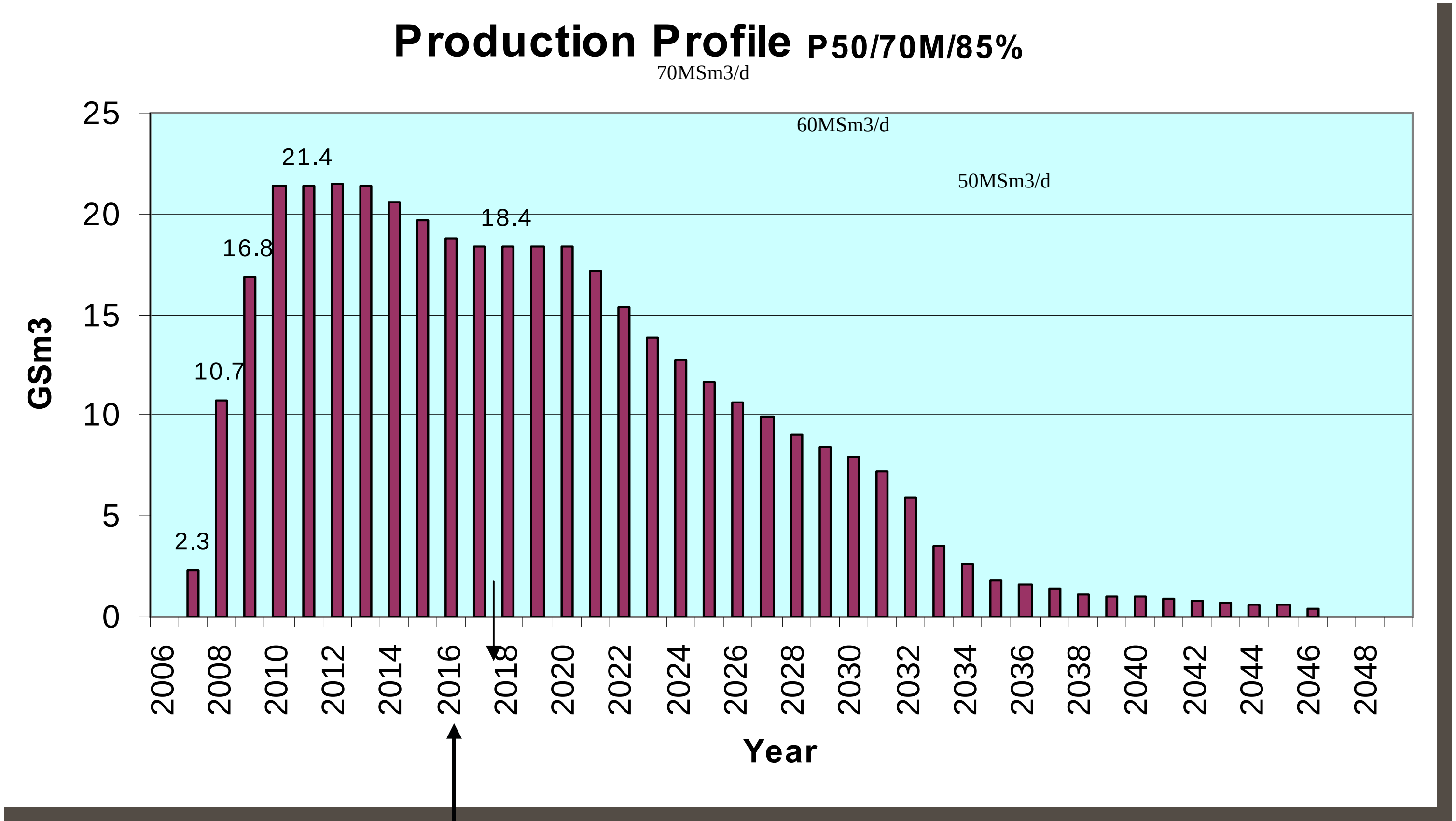
Ormen Lange, Gas from deepwater Mid-Norway to UK market
Mega project on time and cost

Production Profile

Ormen Lange Recoverable Reserves				
	Expected	P90	P50	P10
RF / Total (%)	75	68	75	81
Recoverable Gas (GSm3)	399	310	397	490
Recoverable Cond. (MSm3)	29	19.5	28.5	39.1



Future Compression

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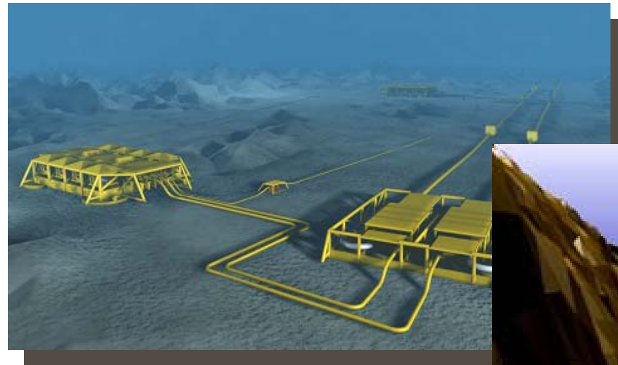
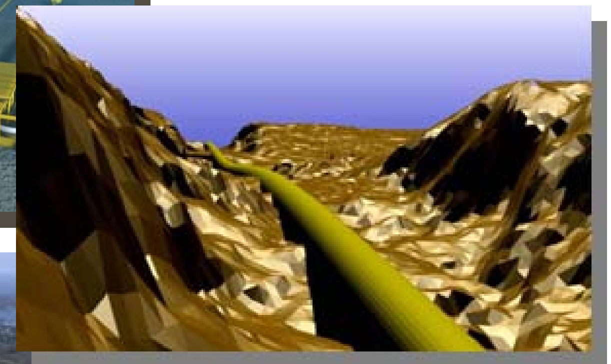
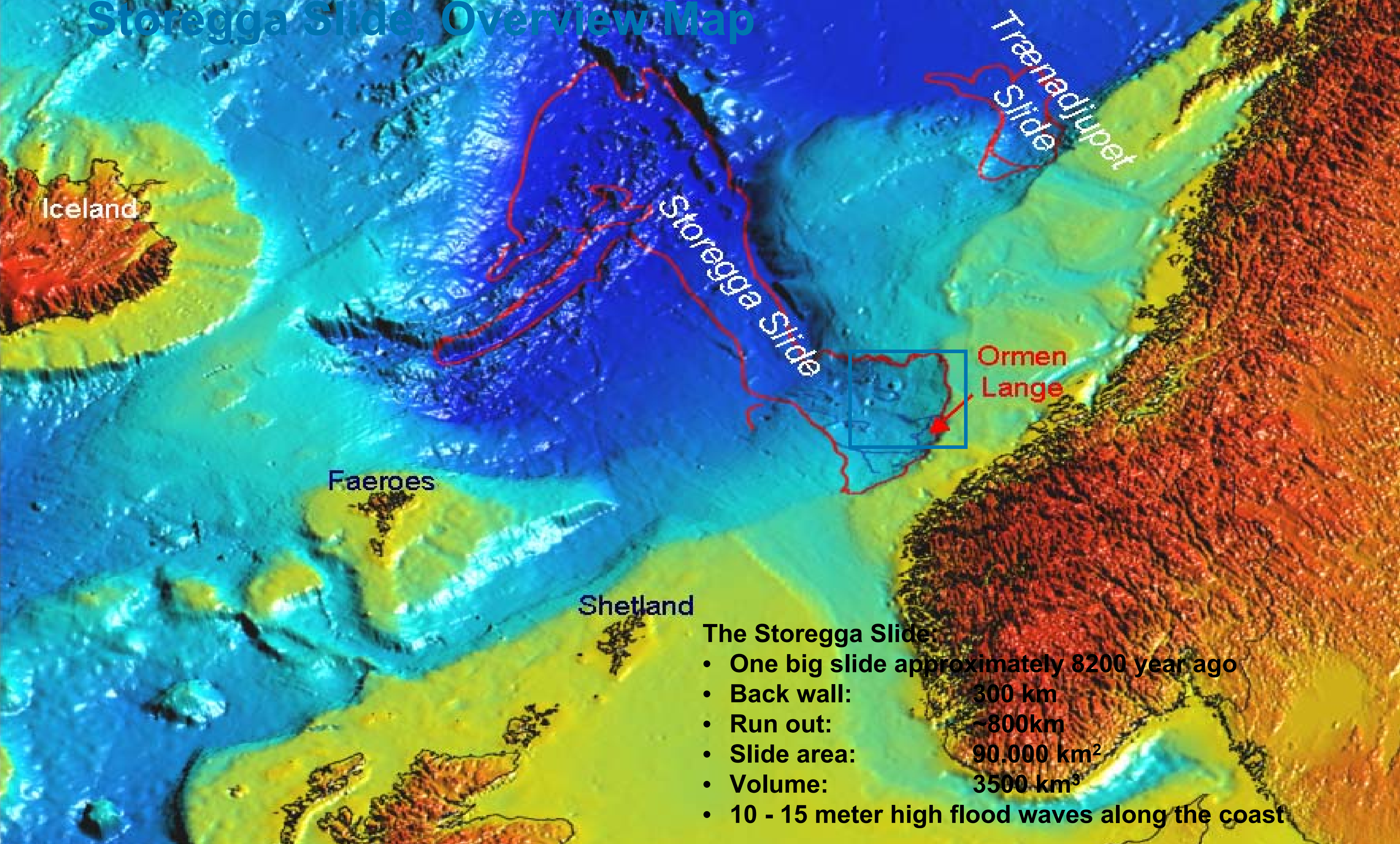
Ormen Lange
- consists of

- ✓Field developments offshore
- ✓Pipelines to shore
- ✓Gas plant on land for processing and export compression
- ✓Pipeline to UK
- ✓Gas to UK markets



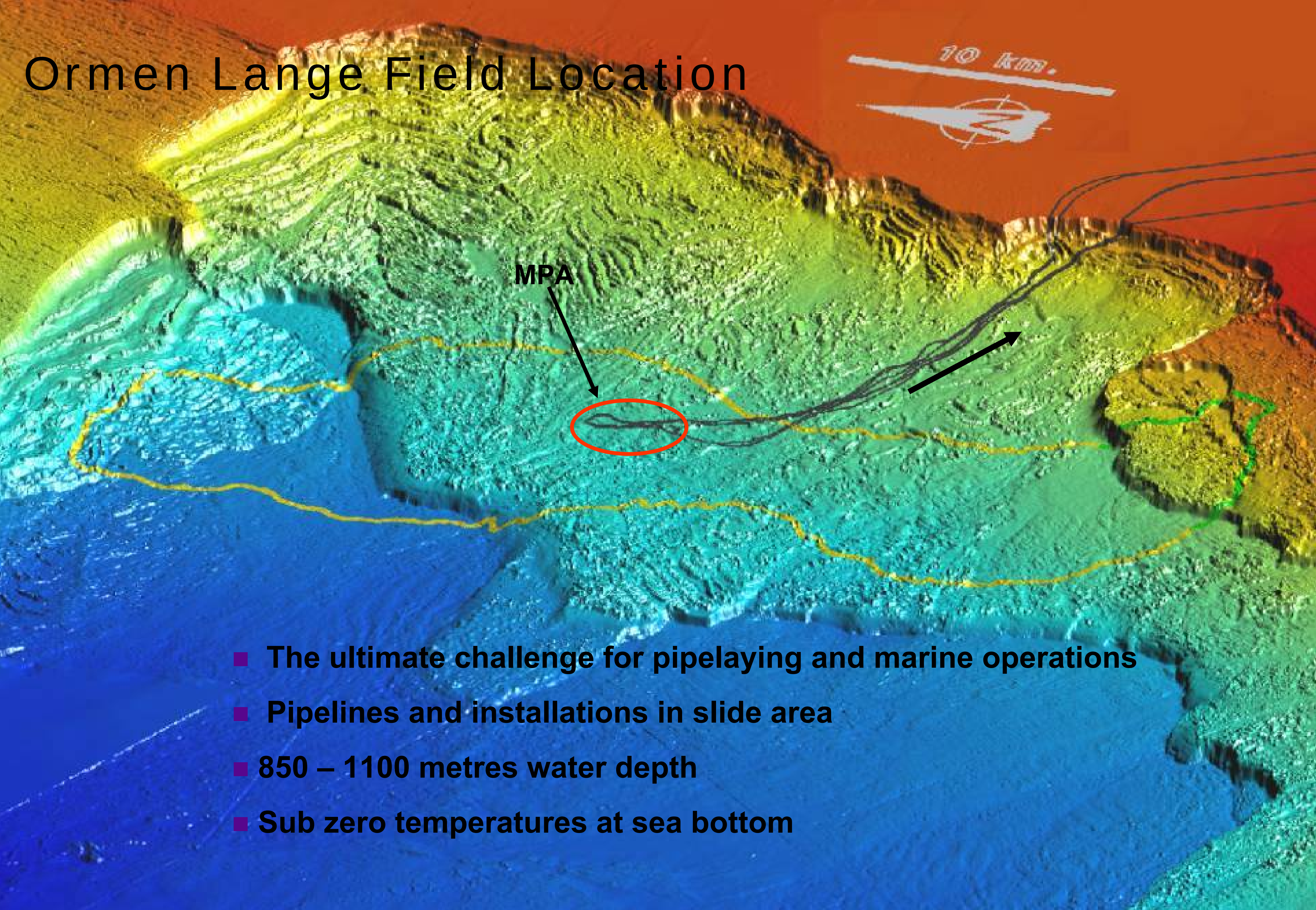


Storegga Slide, Overview Map



The Storegga Slide:
- One big slide approximately 8200 year ago
- Back wall: 300 km
- Run out: ~800km
- Slide area: 90.000 km^2
- Volume: 3500 km^3
- 10 - 15 meter high flood waves along the coast

Ormen Lange Field Location

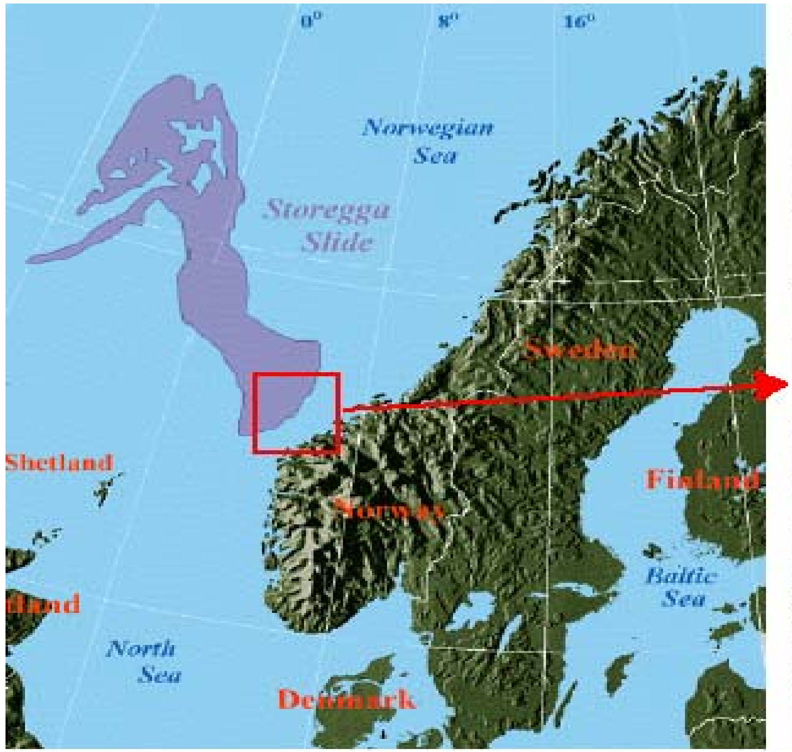


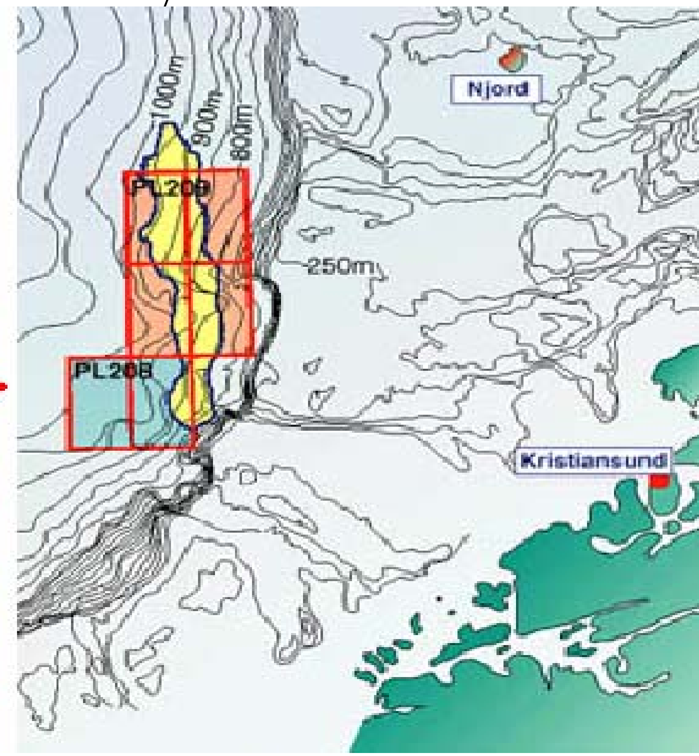
- The ultimate challenge for pipelaying and marine operations
- Pipelines and installations in slide area
- 850 – 1100 metres water depth
- Sub zero temperatures at sea bottom

Key Information - Ormen Lange Field

- Water depth of 850 - 1100 meter
- 500 GSm^3 (18 TCF) GIIP
- Retrograde Condensate GCR ~10.000 Sm^3/Sm^3
- 120 km off the coast of Norway
- App. 350 km^2 areal extent
- Harsh weather /sea conditions)

– Sand rich turbidite
– App. : 50 m , 90% ntg and 500 md permeability
– 24 Producers (3 Predrilled)
– Subsea development
– Compression as required
– Gas production 12-22 billion Sm3 / year





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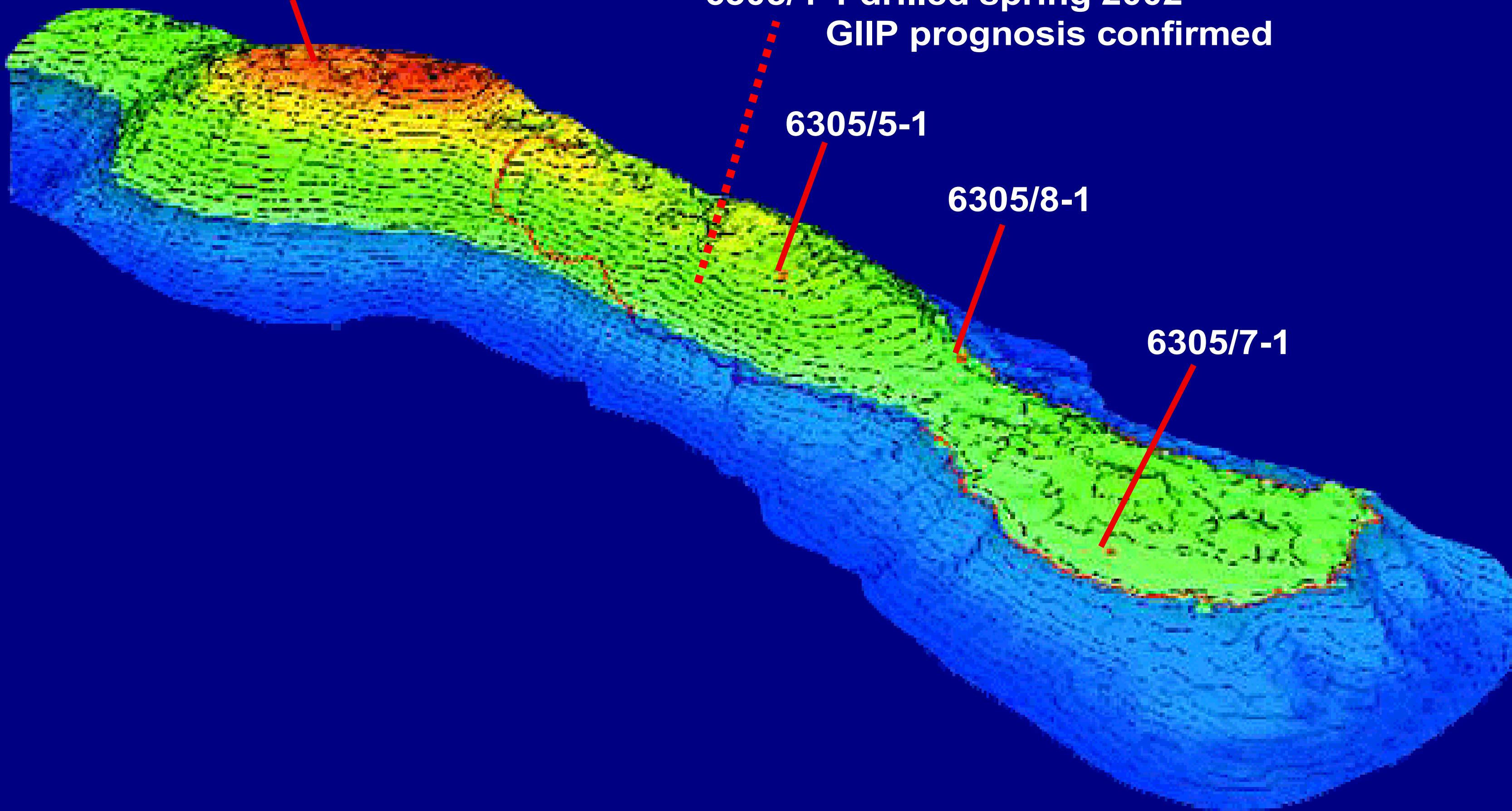
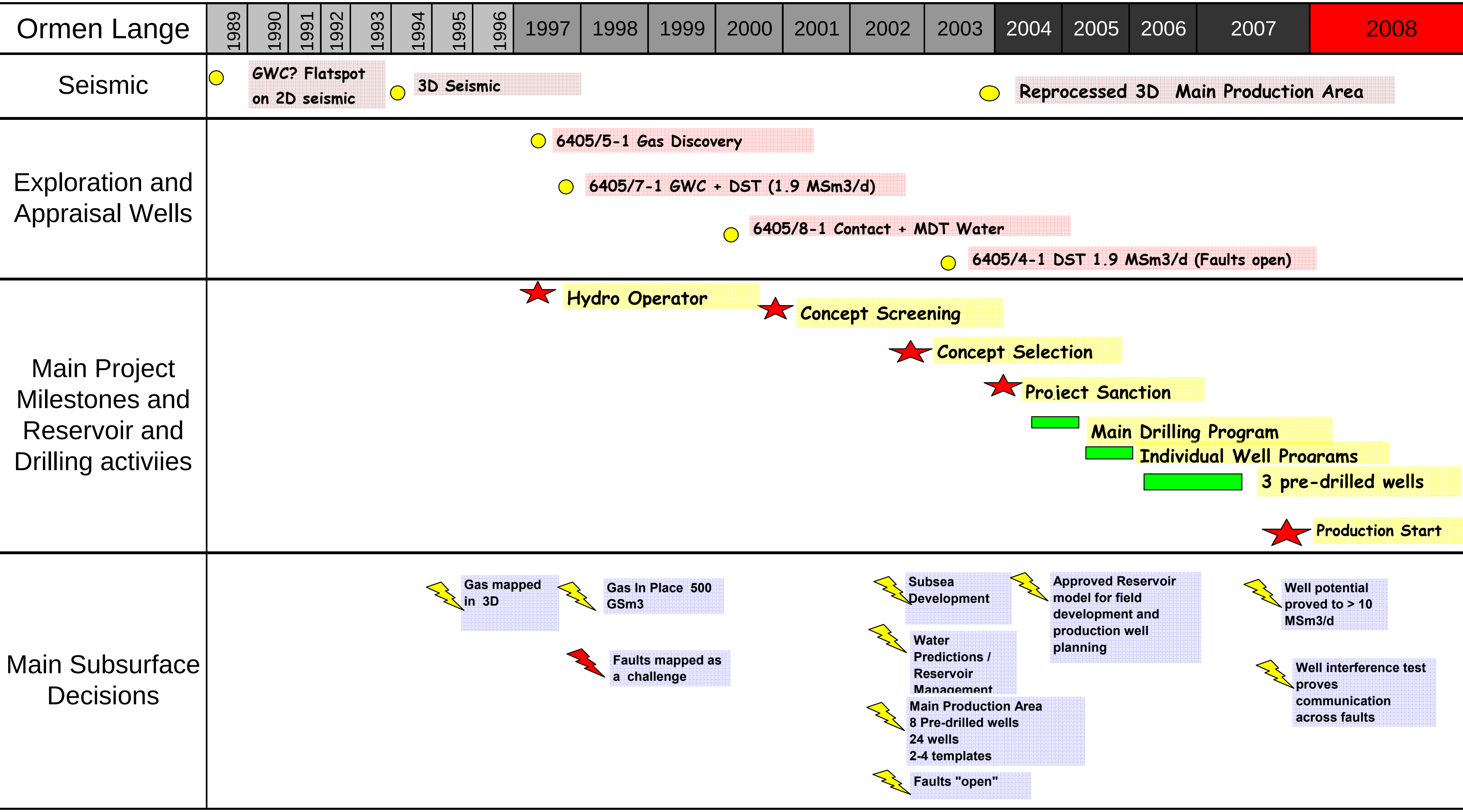
The Top Reservoir Structural Depth Map



Ormen Lange Exploration, appraisal and development plan



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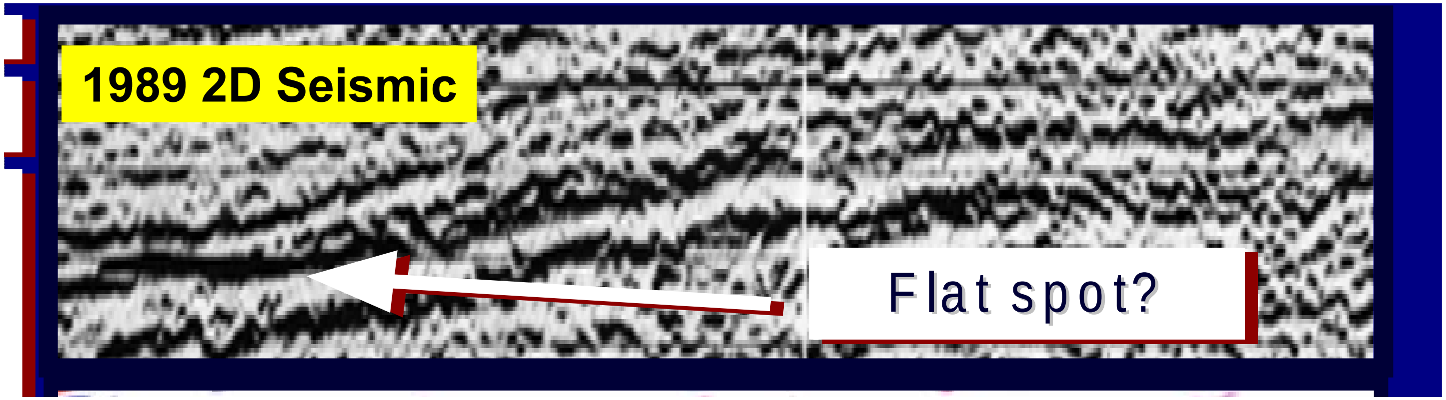
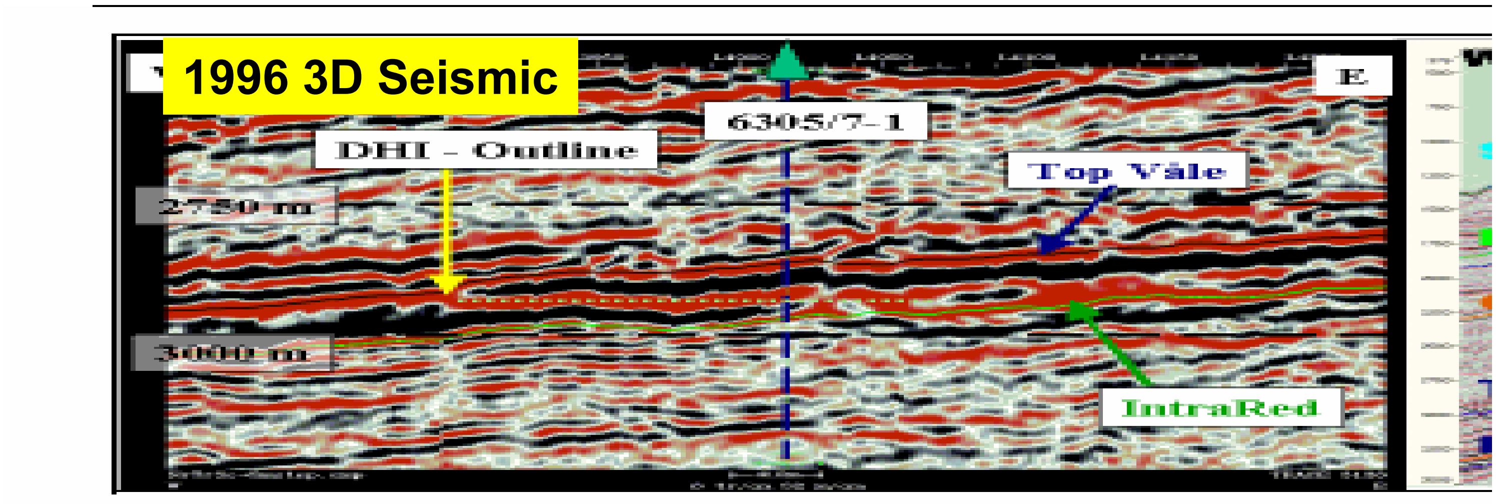
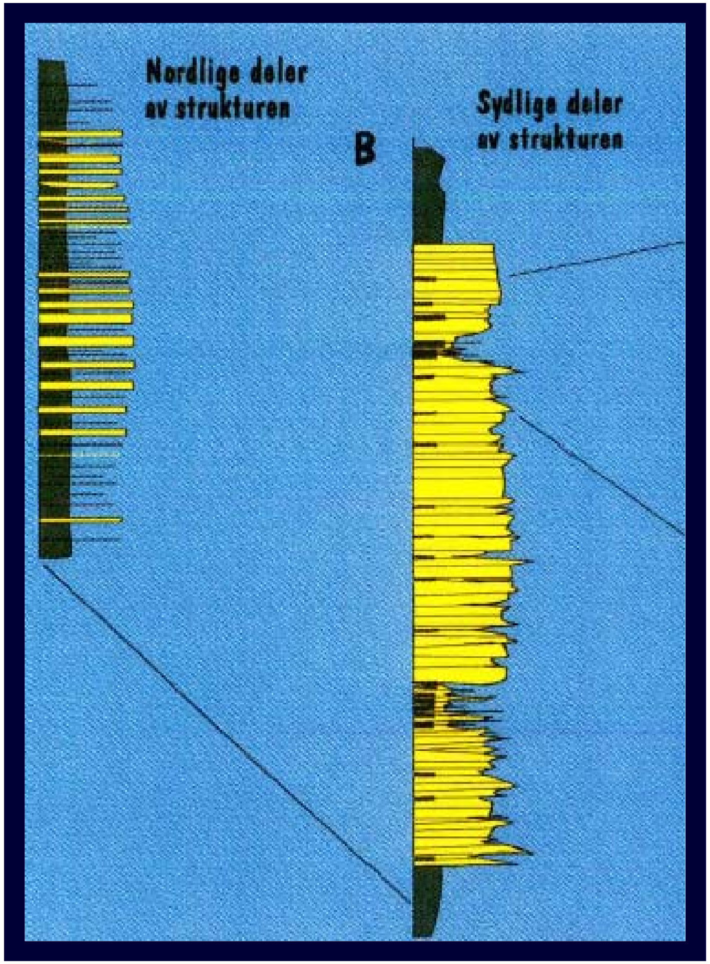
1989 to 1996 – Increased Certainty of Presence of Gas





Prognosis 1989-92 (no wells on Ormen) proven by wells

PROGNOSIS BASED ON ANALOGUES WELLS AND SEISMIC DATA



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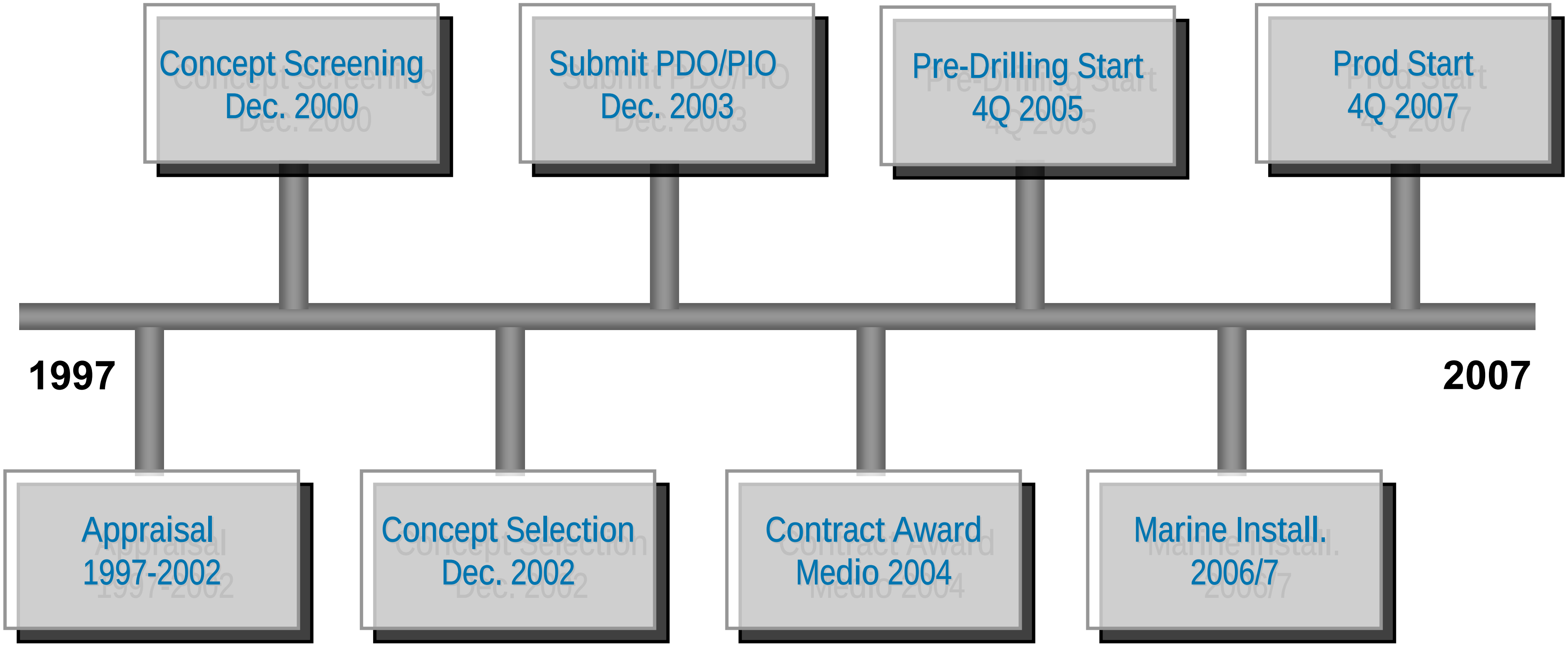
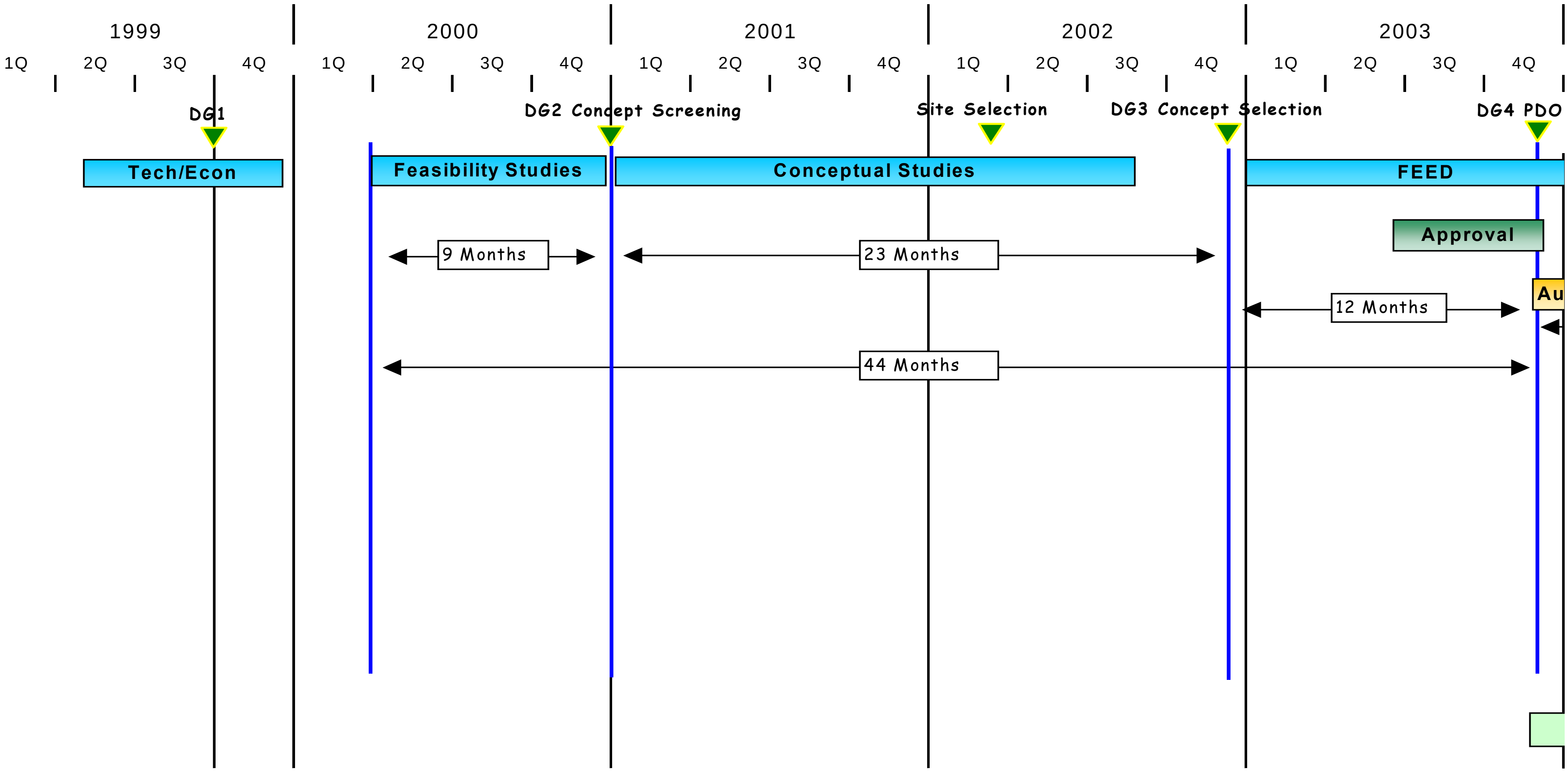
Only minor changes to the GIIP after 1989 for EGGA (main Reservoir)

Key Project Milestones



Ormen Lange Project Summary Schedule



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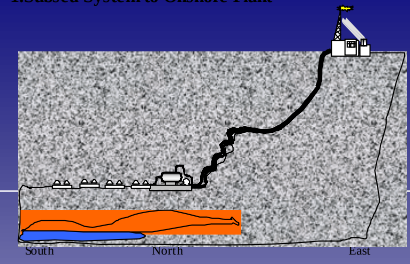
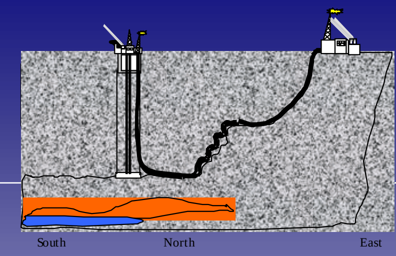
Screening Work

- 4 x 4
- step-functions
- transportation

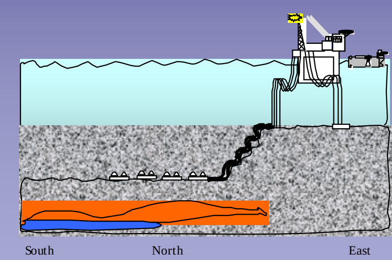
1.Subsea System to Onshore Plant



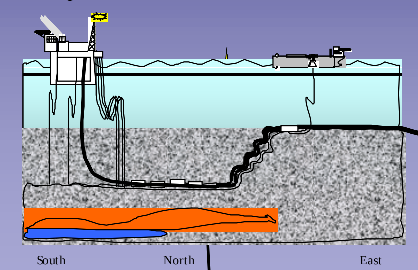
2.Deepwater Platform to Onshore Plant

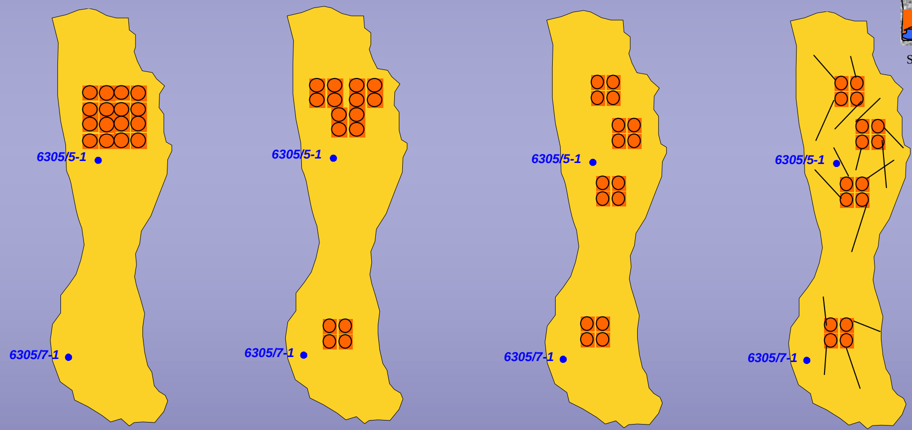


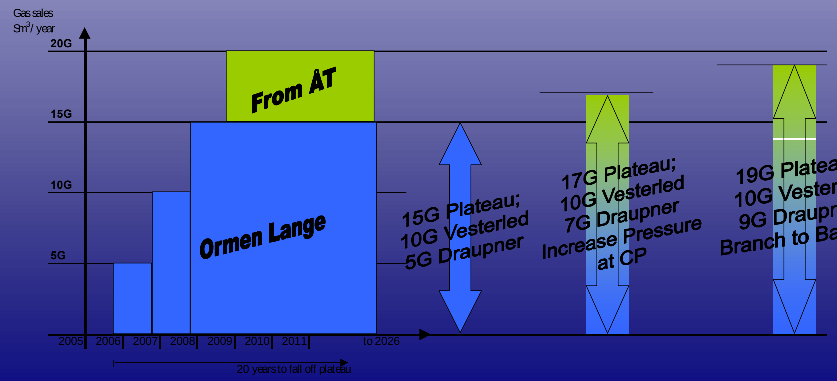
3.Shallow Water Platform

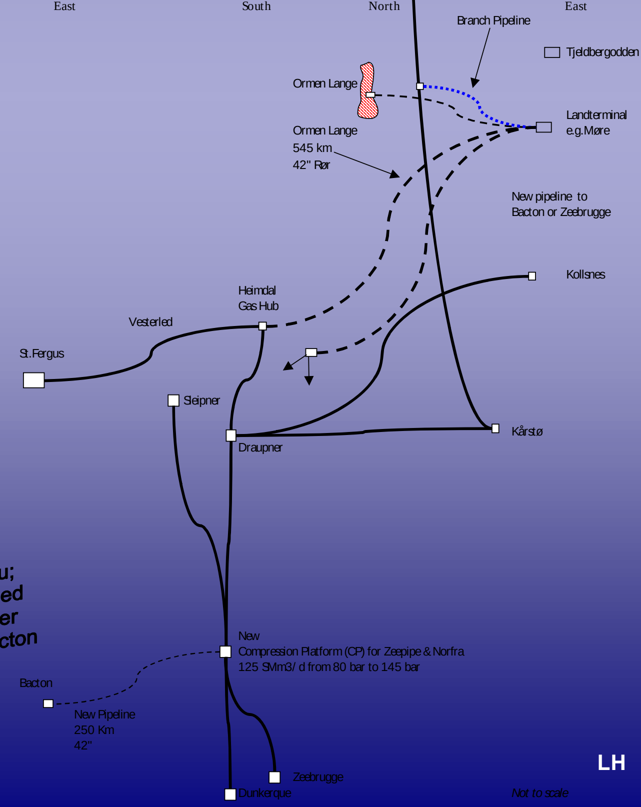


4.Deepwater Platform









Ormen Lange

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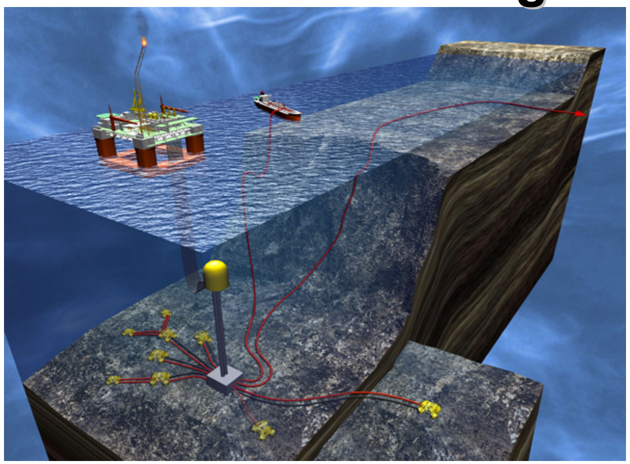
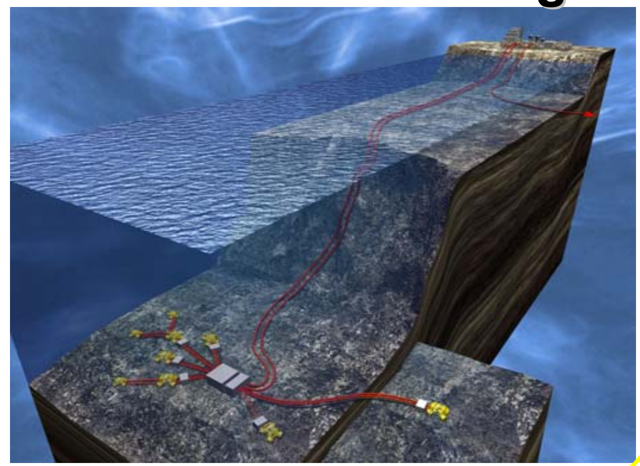
Ormen Lange flow assurance history

Offshore Processing



Onshore Proccessing



Flow assurance highest project risk prior to concept selection

- Risk of hydrate/ice formation
- Lack of viable hydrate remediation method
- Security of gas supply

Ormen Lange Possible well layouts at Concept Selection (2002)

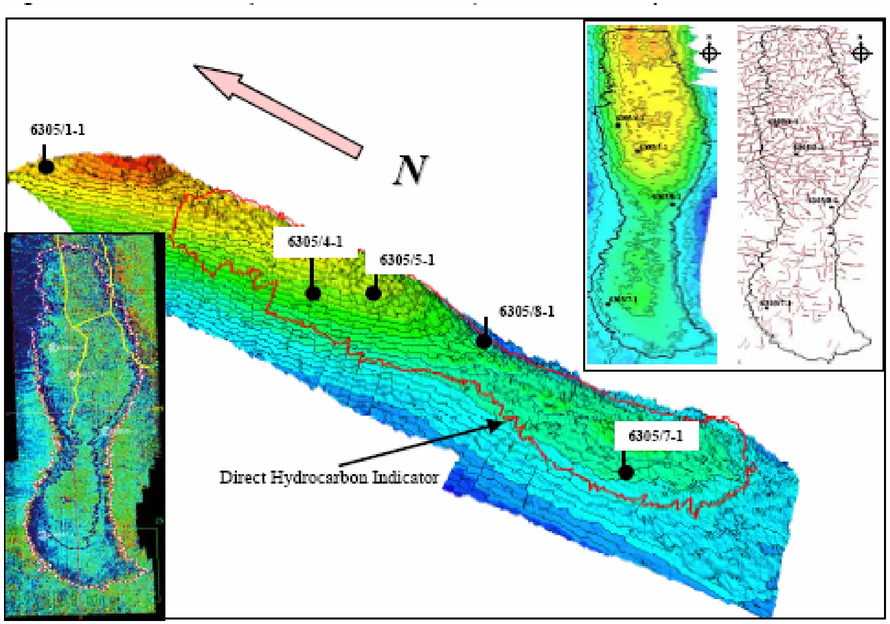
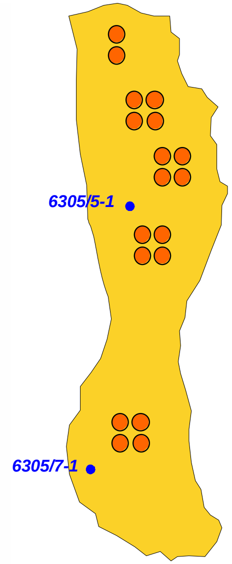


Figure 11 The DHI and the Ormen Lange wells on top reservoir structure map



Distributed subsea well cluster

For:

Mitigate against possible segmentation due to Faults

Against

Challenging Flow Assurance Strategy

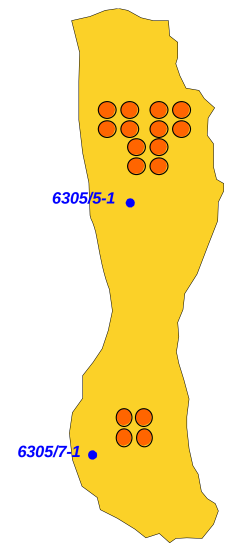
One main well cluster
One tieback cluster

For:

Easiest Flow Assurance Strategy

Against

Risk of low reserves due to (fault) segmentation



- Concept Selection
  - Subsea development selected
  - reduces total no of wells
  - mitigates risk of sealing faults

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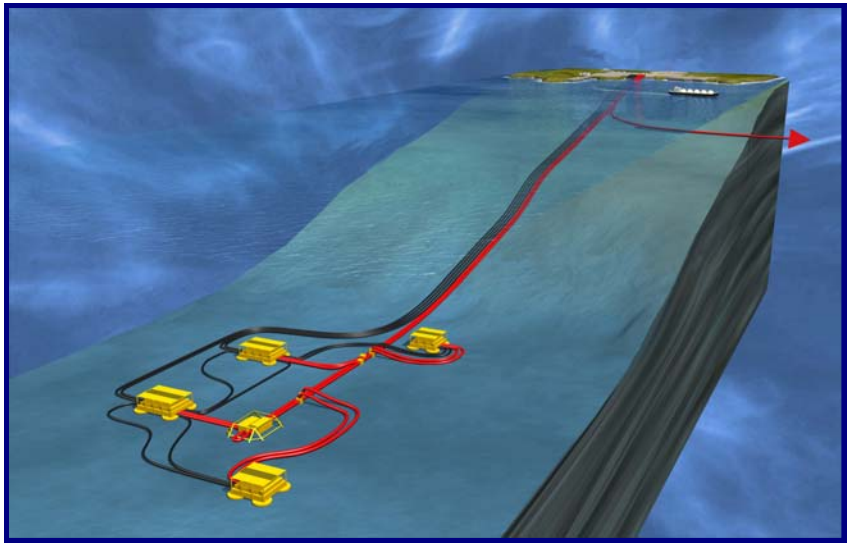
End 2002 (Subsea vs Dry wells) was a significant point in partner discussions

Flow Assurance Definition

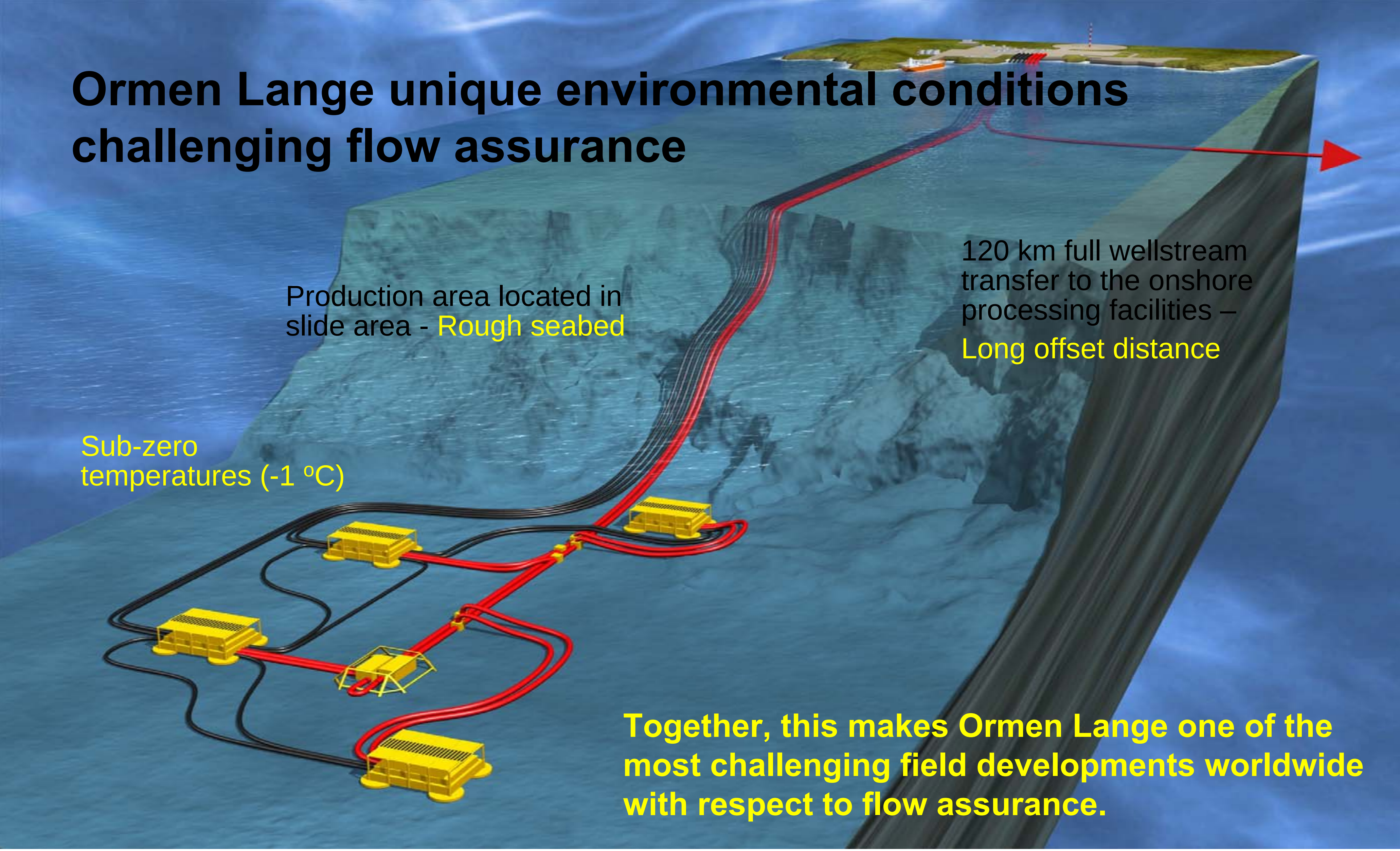
"The ability to produce and transport multiphase fluids from the reservoir(s) to the processing plant"

Key issues:

- Thermohydraulic analysis
- Multiphase flow
- Hydrate management
- Operability
- Design premises
- System integrity



Ormen Lange unique environmental conditions challenging flow assurance



Together, this makes Ormen Lange one of the most challenging field developments worldwide with respect to flow assurance.

Ormen Lange flow assurance technology
Multiphase flow risk mitigation

Integrated reservoir and pipeline model

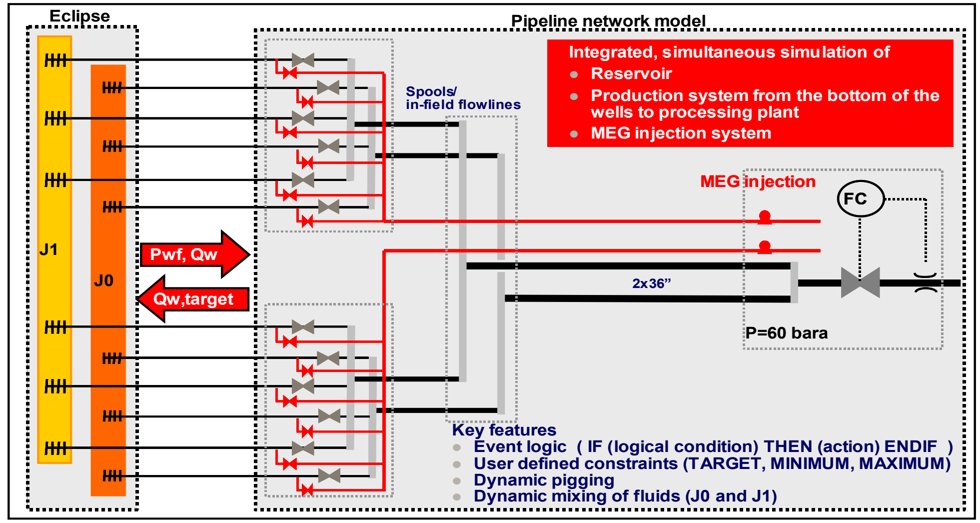
- Simulation “from reservoir to processing plant” including
  - Reservoir
  - Coupling to the wellbore
  - Wells and surface pipeline network
  - Processing facilities
  - MEG injection system

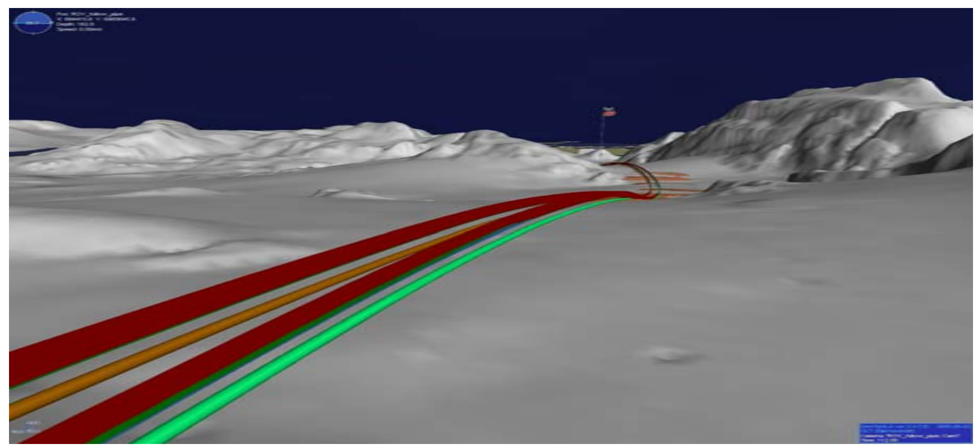
  in one single simulation model

- Establish and verify production profiles taking into account total production system limitations

- Define operating conditions (Q, P, T, dP) in all parts of the total production system during the entire lifetime of the field

- Define compression requirements





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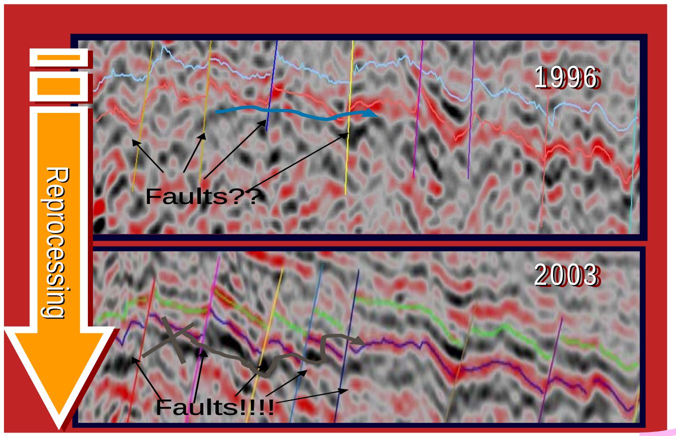
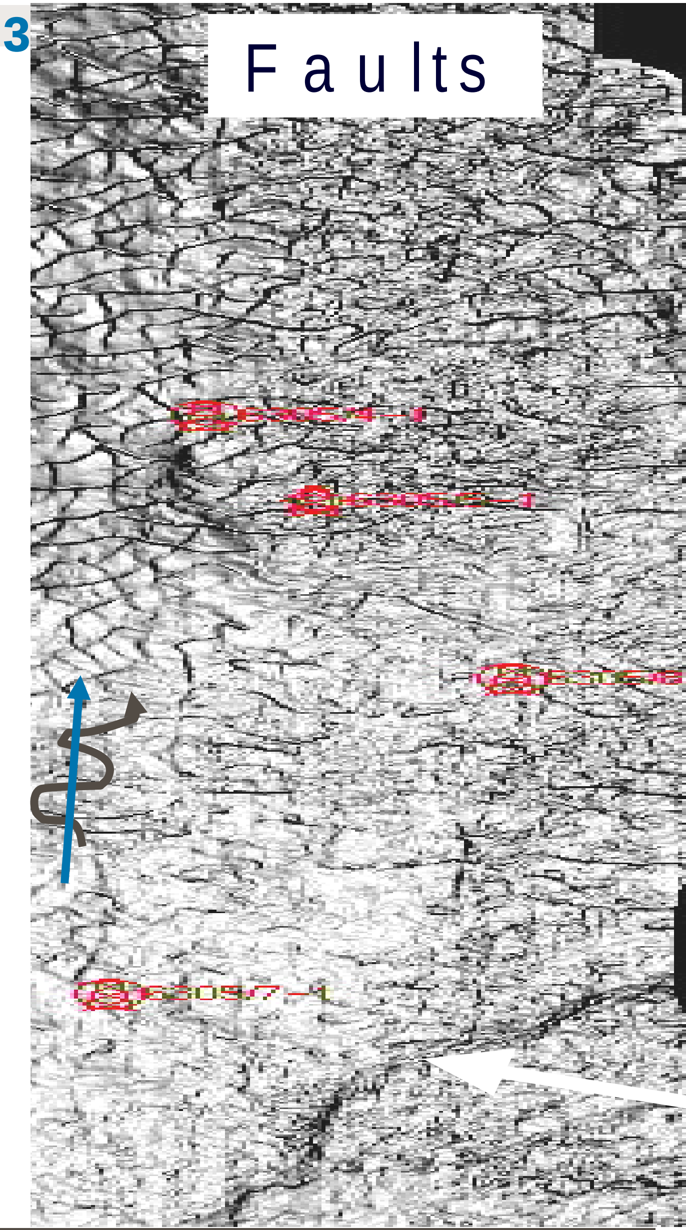
Seismic Interpretation Challenges identified in 2000-2003

- Seismic Interpretation shows more than 1000 faults found as polyginal faults with < 10 m to > 60 m throw
- More faults makes gas move more tortuous;
- Reprocessing (2003)
  - Improved depth data
  - Improved fault imaging main production area for well planning

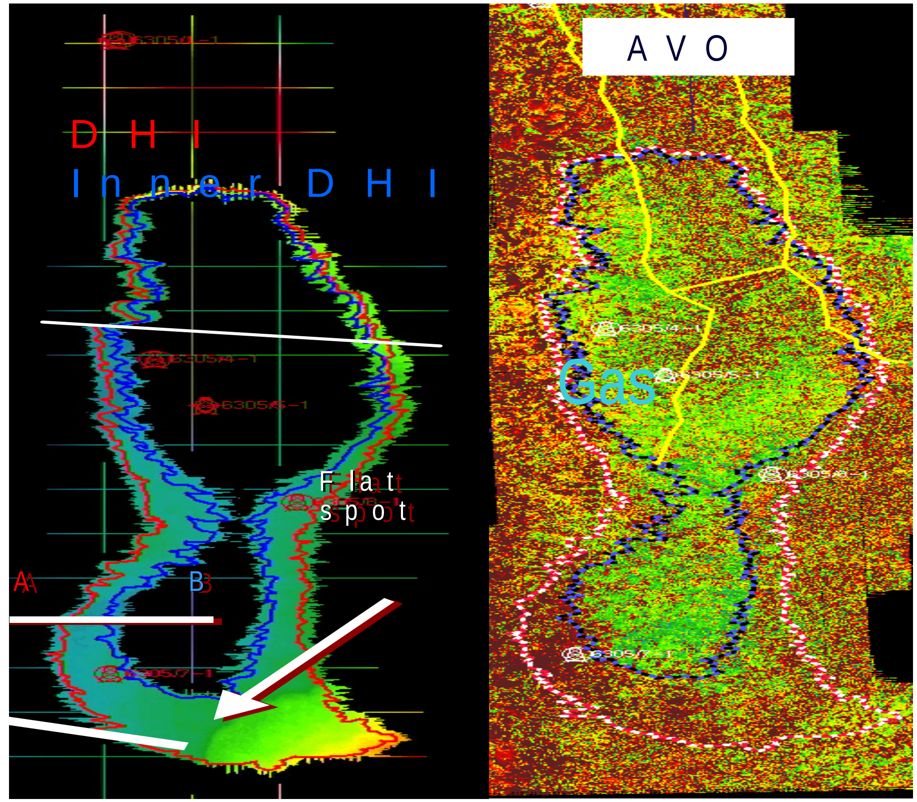




Faults better defined on reprocessed data but generally small changes

Seismic 1996-2000 (Project Sanction)

- 3D Seismic
  - Field outline proved
  - Gas Water Contact Mappable over extent of field
  - Gas seen on AVO seismic analysis
- GIIP estimated to 500 GSm3 (still base case)
- Challenges in Depth conversion (south) -> PSDM reprocessing
- Faults seen as main issue



Only minor changes to the seismic interpretation since 2001 EGGA

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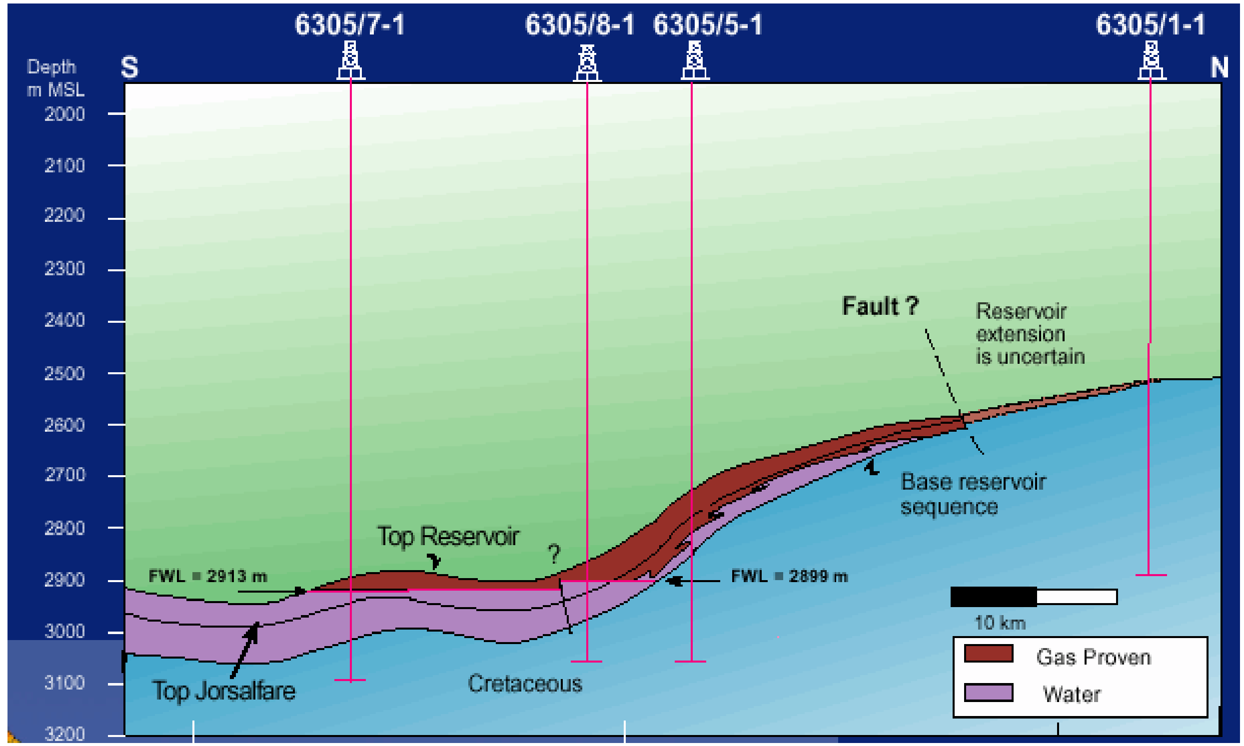
2002: Concept Selection: Water Handling Strategy decided:

- Gas Water Contact on Ormen at 2917 mMSL
- Contact steps more than 100 m northwards due to stratigraphical trapping /Faults
- Perched water ("lakes")
- Main strategy
  - **Stay away** from main aquifer in the south
  - **Monitor** formation water break trough in producers (multiphase measurements)
  - If considerable formation water breaks trough **reduce well rate** to formation water free production or **shut in** well



Even 2 m oil!!

End 2002 : Water was high on risk decision to be closed out

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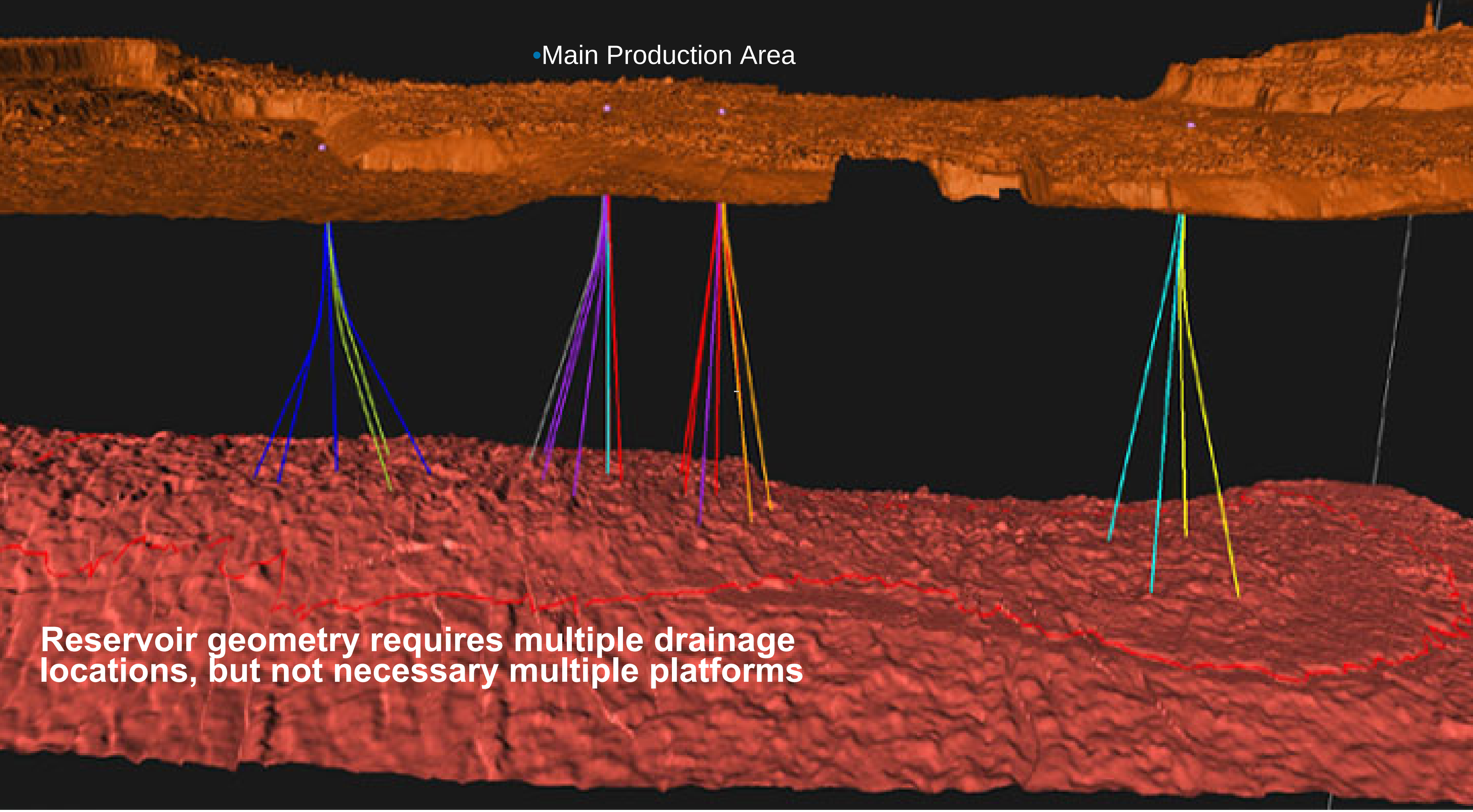
Drainage



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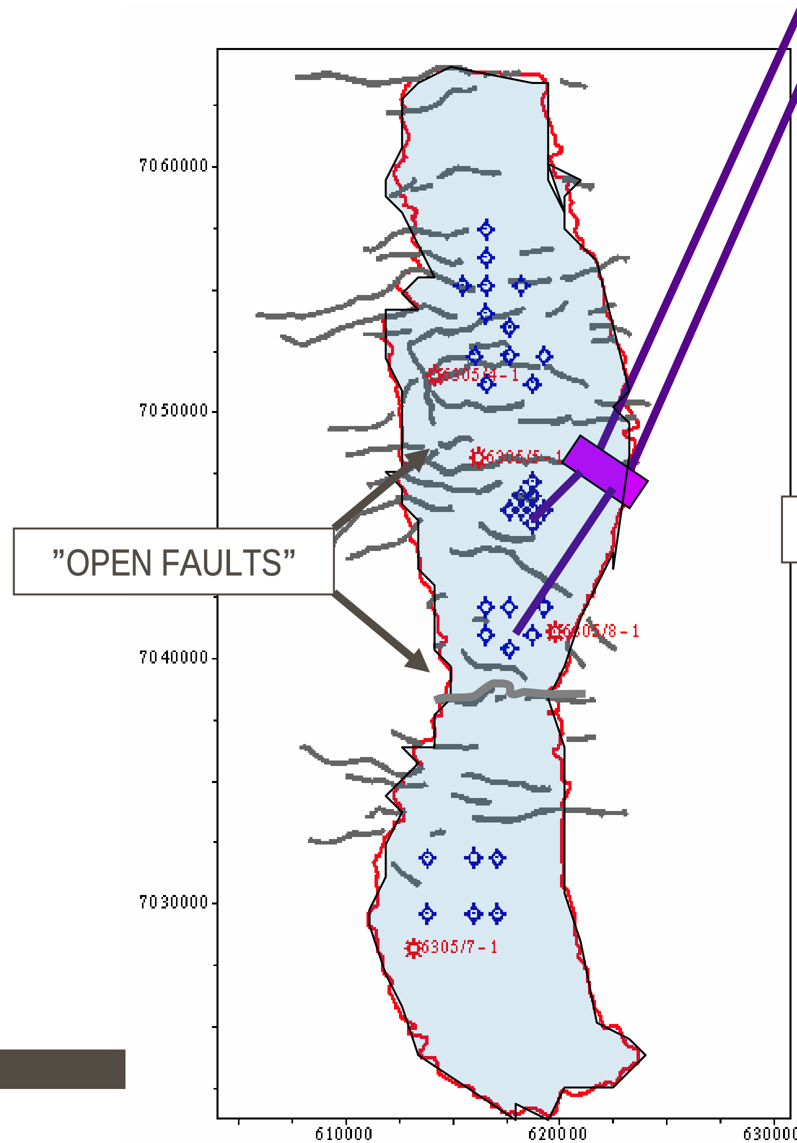
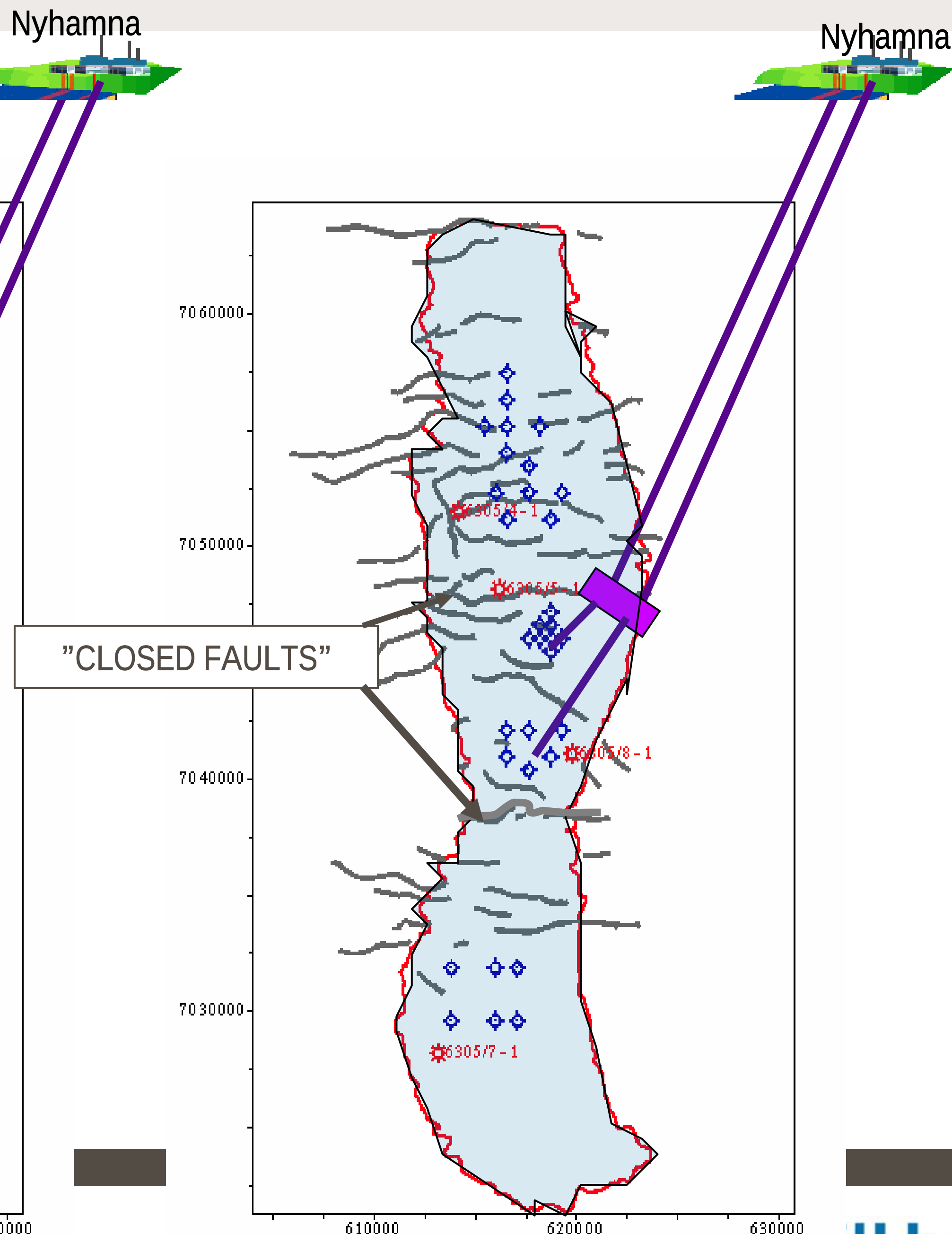
2003: Project Sanction : Ormen Well and Template Schedule Strategy

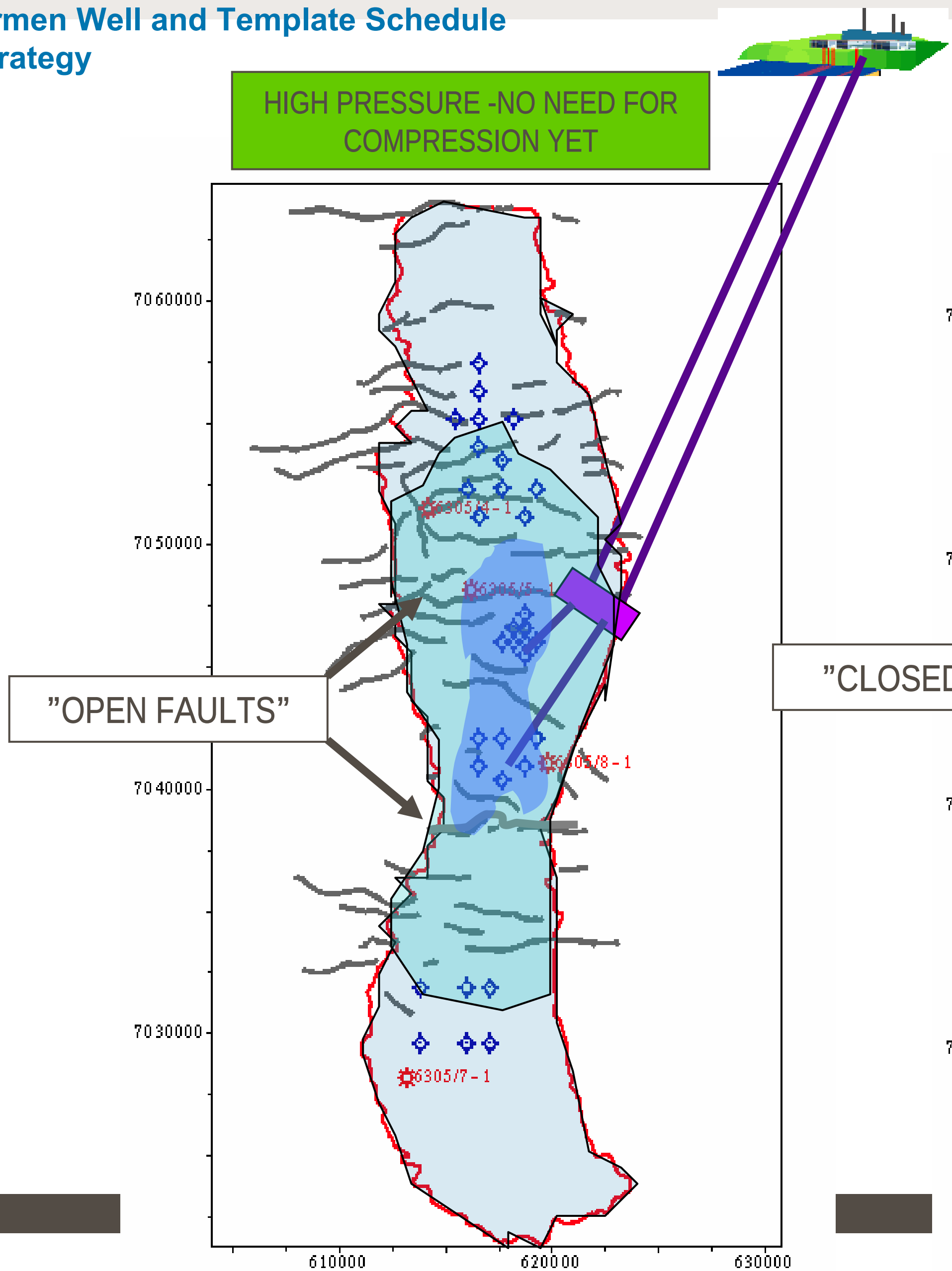


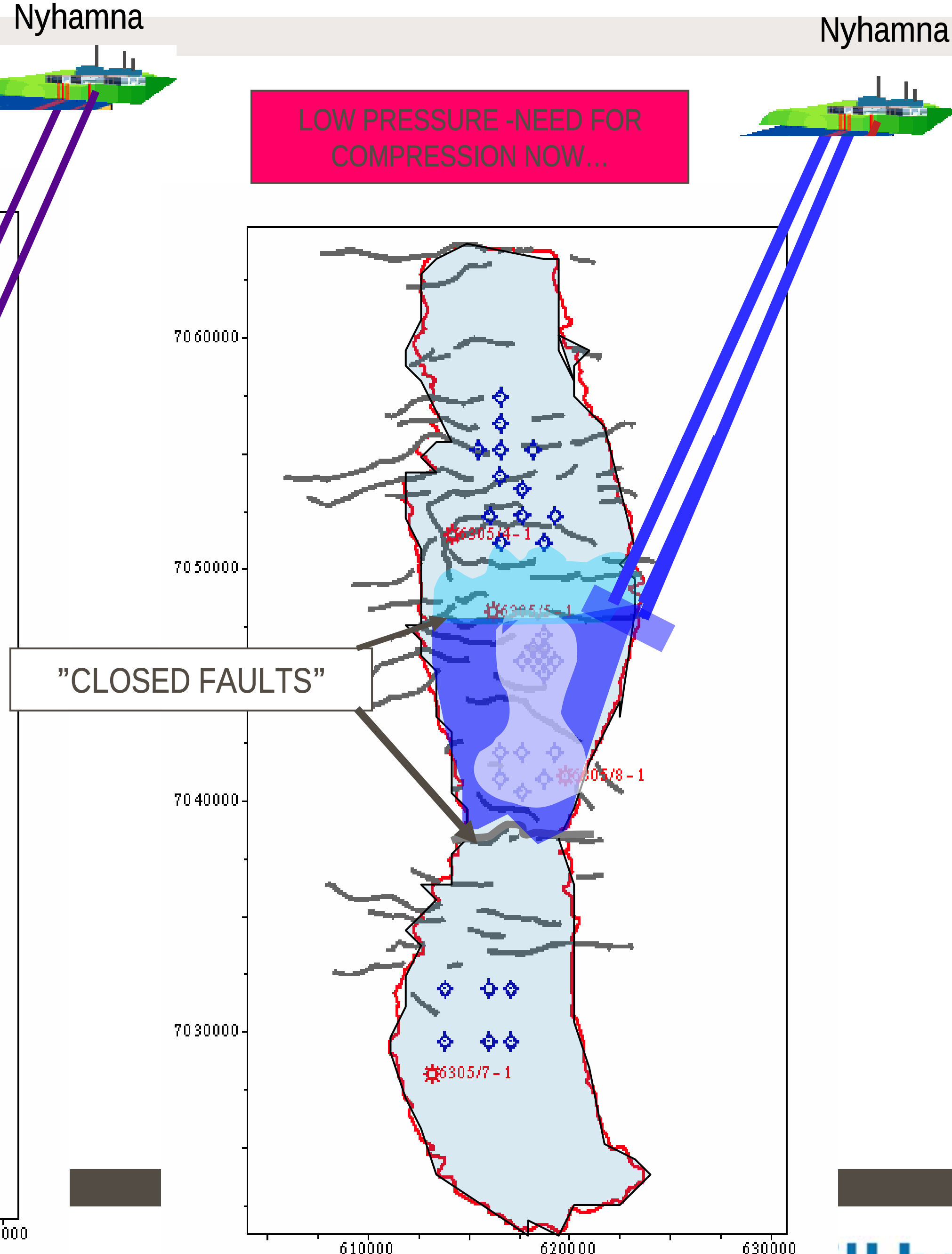


AT PRODUCTION START

Hydro

2003: Project Sanction : Ormen Well and Template Schedule Strategy

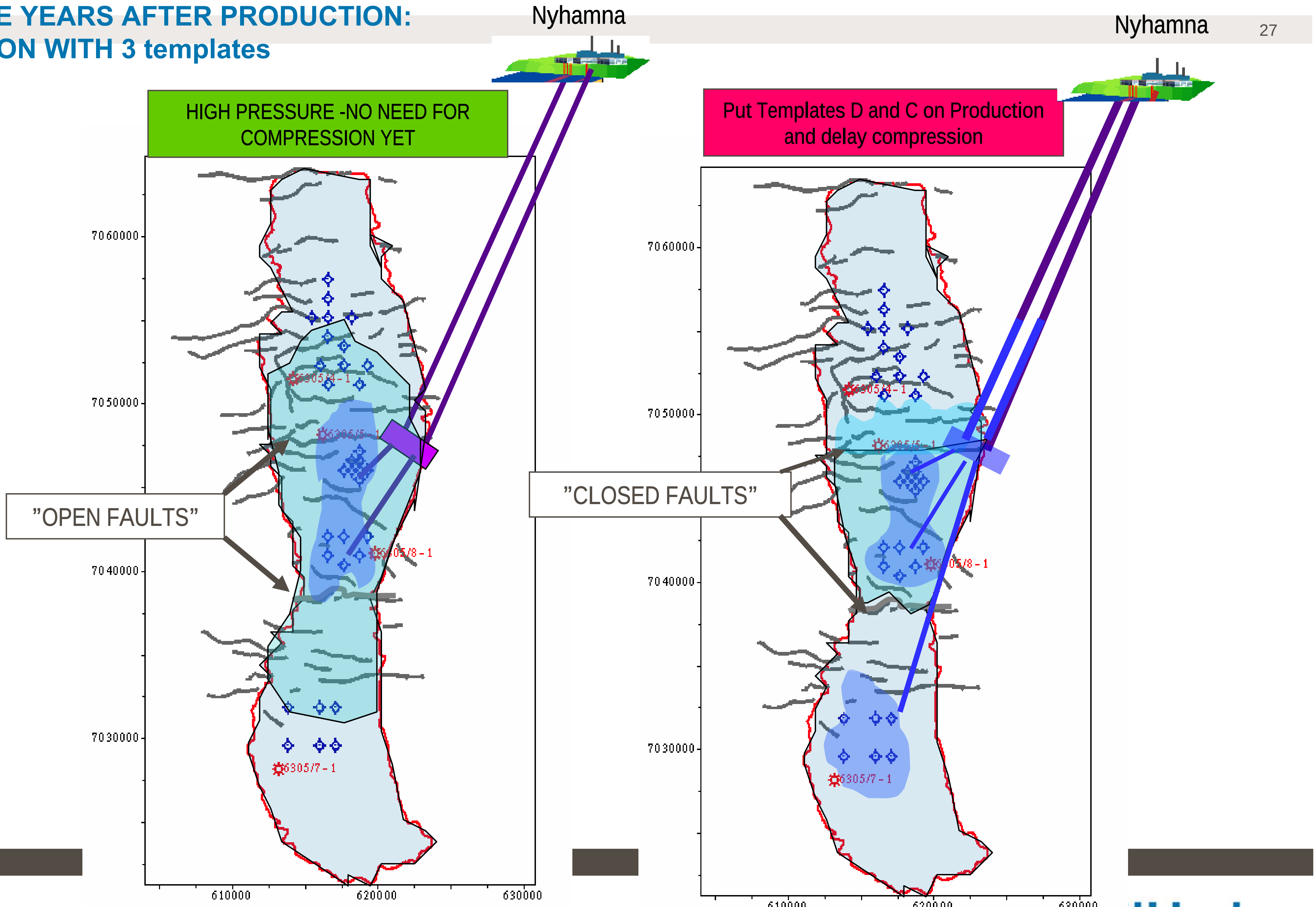




AFTER PRODUCTION START-BEFORE TEMPLATE 3

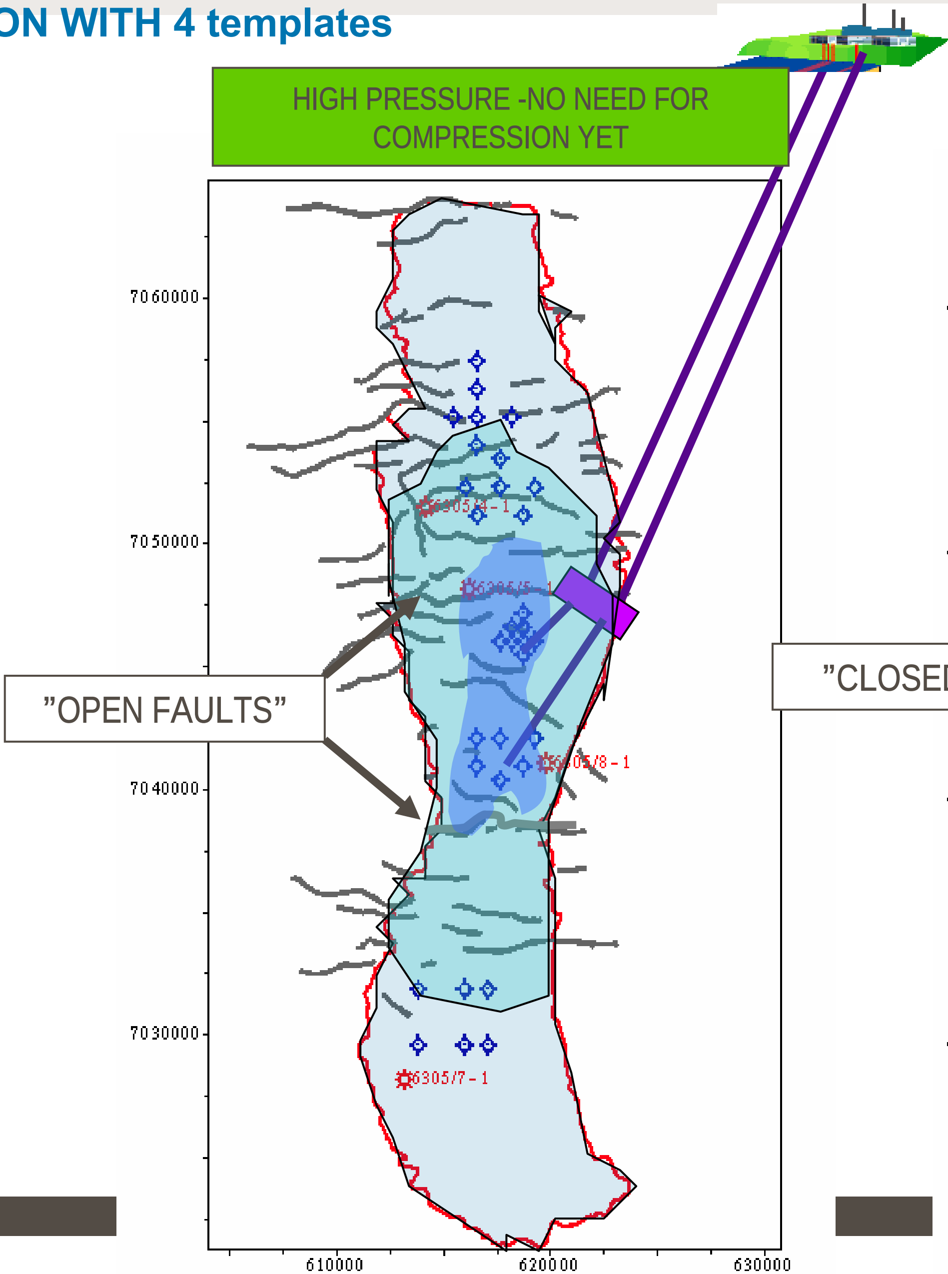
Hydro

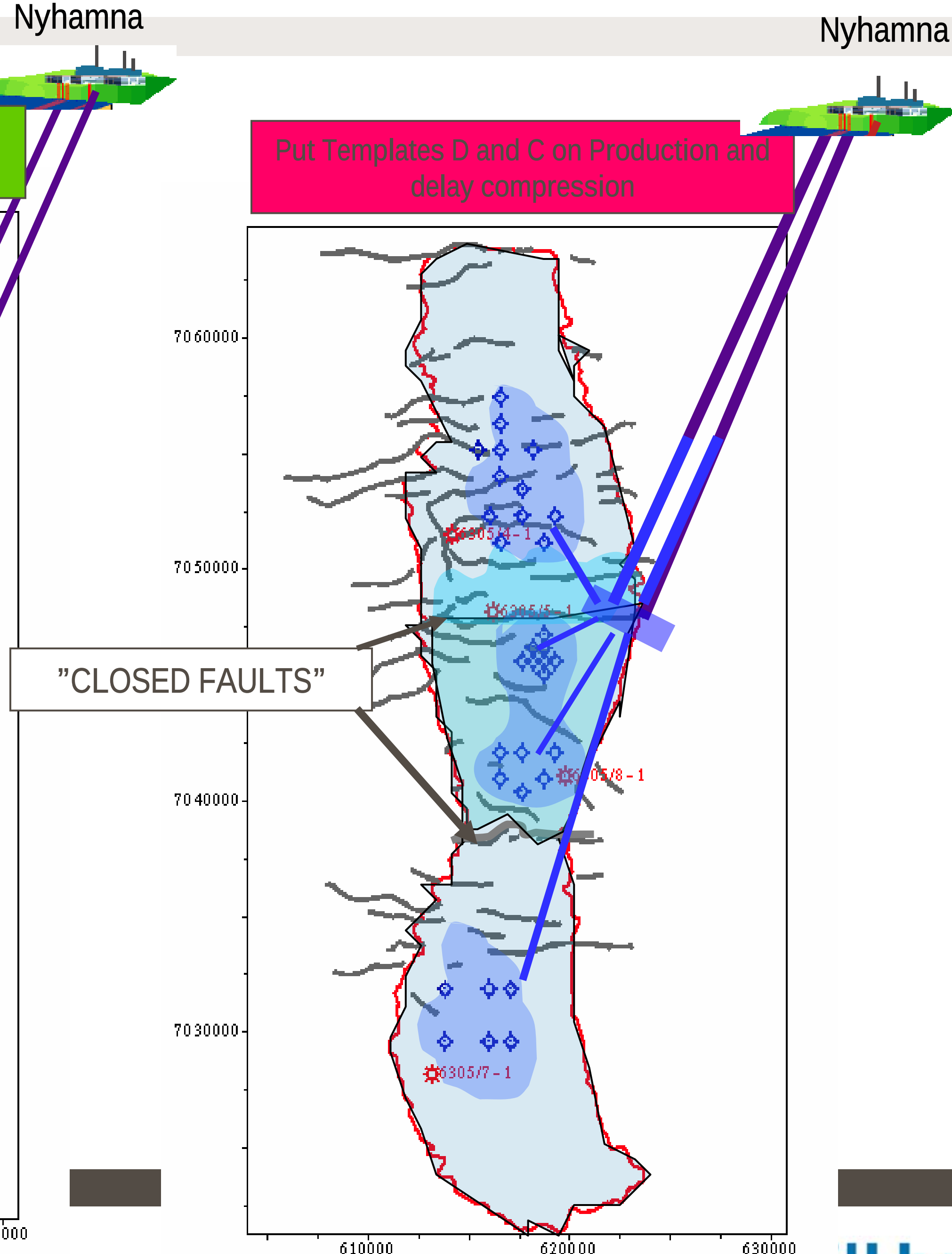
SOME YEARS AFTER PRODUCTION: OPTION WITH 3 templates



AFTER PRODUCTION START-PLACE TEMPLATE 3 IF AND WHERE REQUIRED

SOME YEARS AFTER PRODUCTION: OPTION WITH 4 templates





AFTER PRODUCTION START-PLACE TEMPLATE 4 IF AND WHERE REQUIRED

Hydro

Ormen Lange - Main Drilling Program- Pre-Drilling Strategy

- Spreading of the wells North-South (East-West secondly).
  - Cover large structural segments
  - wells from template B stretch to the North and wells from template A drill dominantly towards the South and West.
  - Place wells in areas with large segments.
  - Mitigate against the scenario where all faults are sealing.
- • Thick Egga Isopach.
  - More Egga reservoir, increased well production potential.
- - Proximity to faults.
  - The minimum distance any well should be from a fault is 200 m.

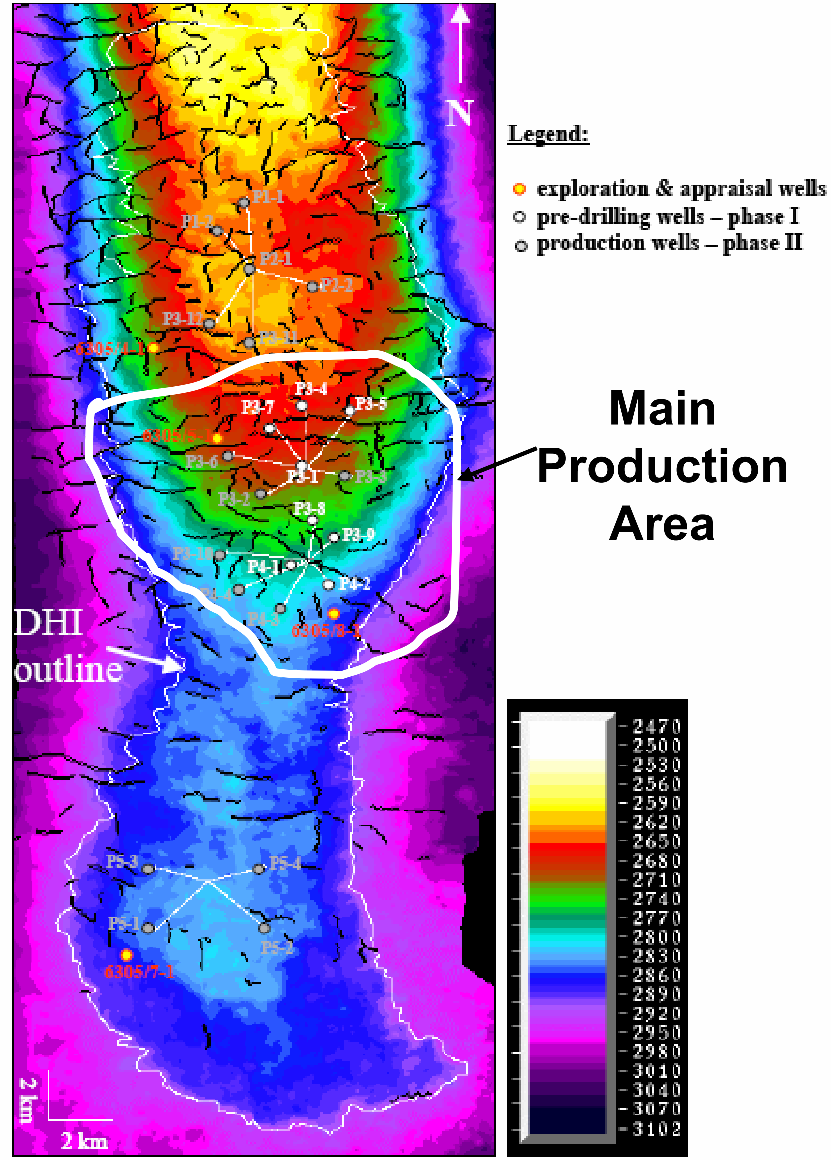


Figure 12: Updated Top Våle map based on the final PSDM velocity model

Ormen: Status Pre-Drilling Jan 2008

- Only 3 Wells actually pre-drilled (4-6 planned)
- Remaining wells to be drilled from 2008 and onwards as required
- 3rd template approved by partners in 2006

Actual Predrilled

Table 8 Summary of updates to pre-drilling targets

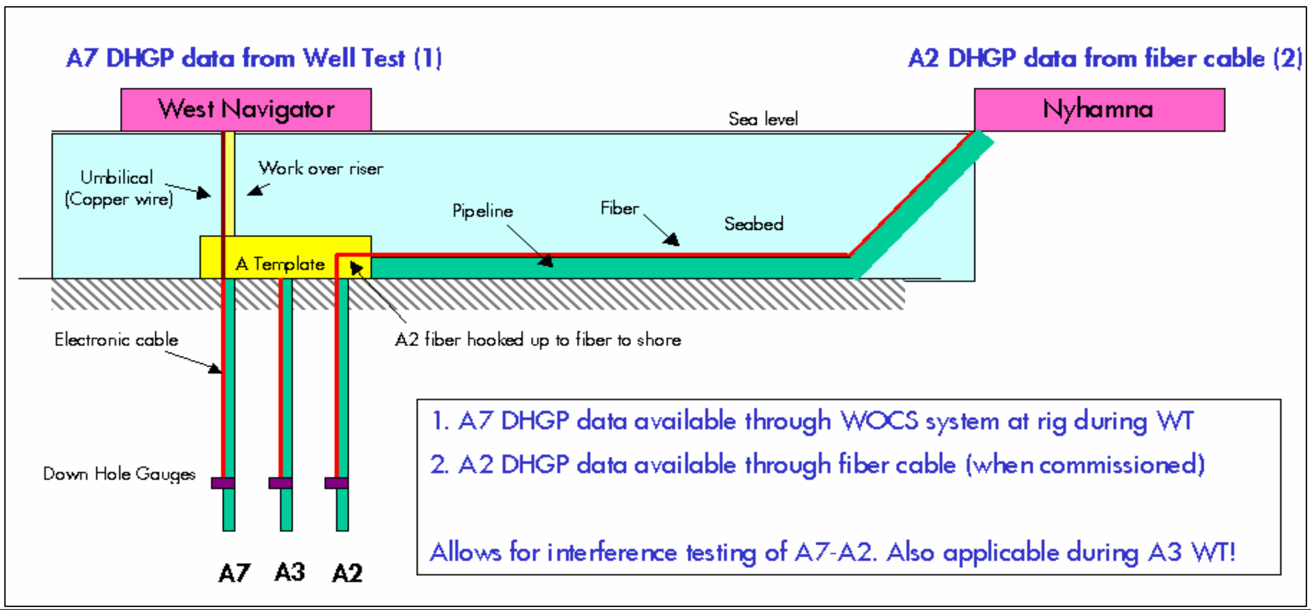
Target Name	Well Name	Planned Step-out	Original Sequence	Original Step-out
P4-1	6305/8-A-7H	350 m	1	396 m
P4-2	6305/8-A-3H	1,075 m	2	1,316 m
P3-9	6305/8-A-2H	1,235 m	3	1,478 m
P3-8	6305/8-A-6H	1,569 m	4	1,015 m
P3-1	6305/5-B-12H	46 m	5	241 m
P3-6	6305/5-B-3H	2,205 m	-	2,205 m
P3-4	6305/5-B-7H	2,422 m	8	2,224 m
P3-5	6305/5-B-8H	2,600 m	-	2,215 m

Test Background

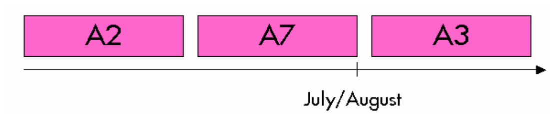
During the well tests of **A7** and **A3** there is an opportunity to investigate potential pressure interference with **A2A.**

The interference test could provide valuable information about the sealing of faults in the Ormen Lange field.

WT and SS control system layout



Well Sequence



Template A area; reactivated faults

Assumptions for Interference Test

- **Base case parameters (A template area)**

  Pres = 287.59 Bar

  T = 89.4 deg C

  k = 523.5 mD

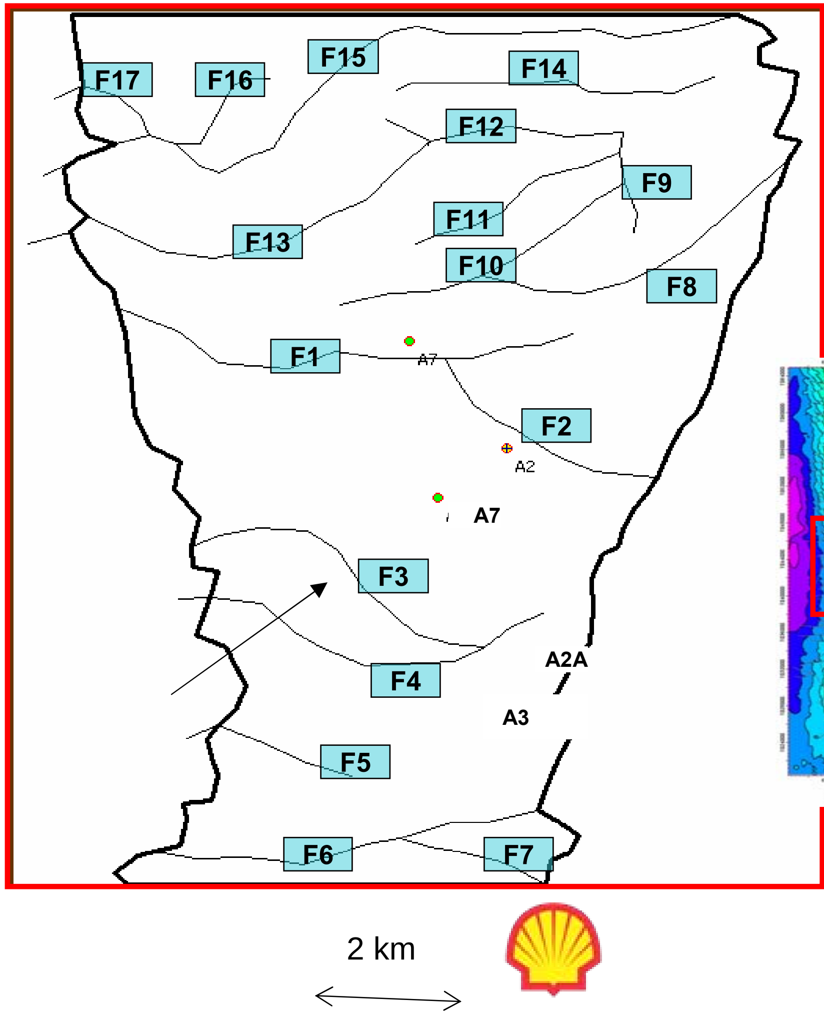
  phi = 0.283

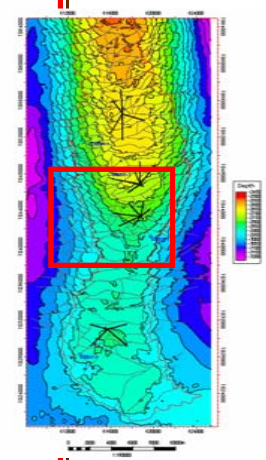
  Net Pay = 50m

  Cg = 2.61e-8 Pa-1

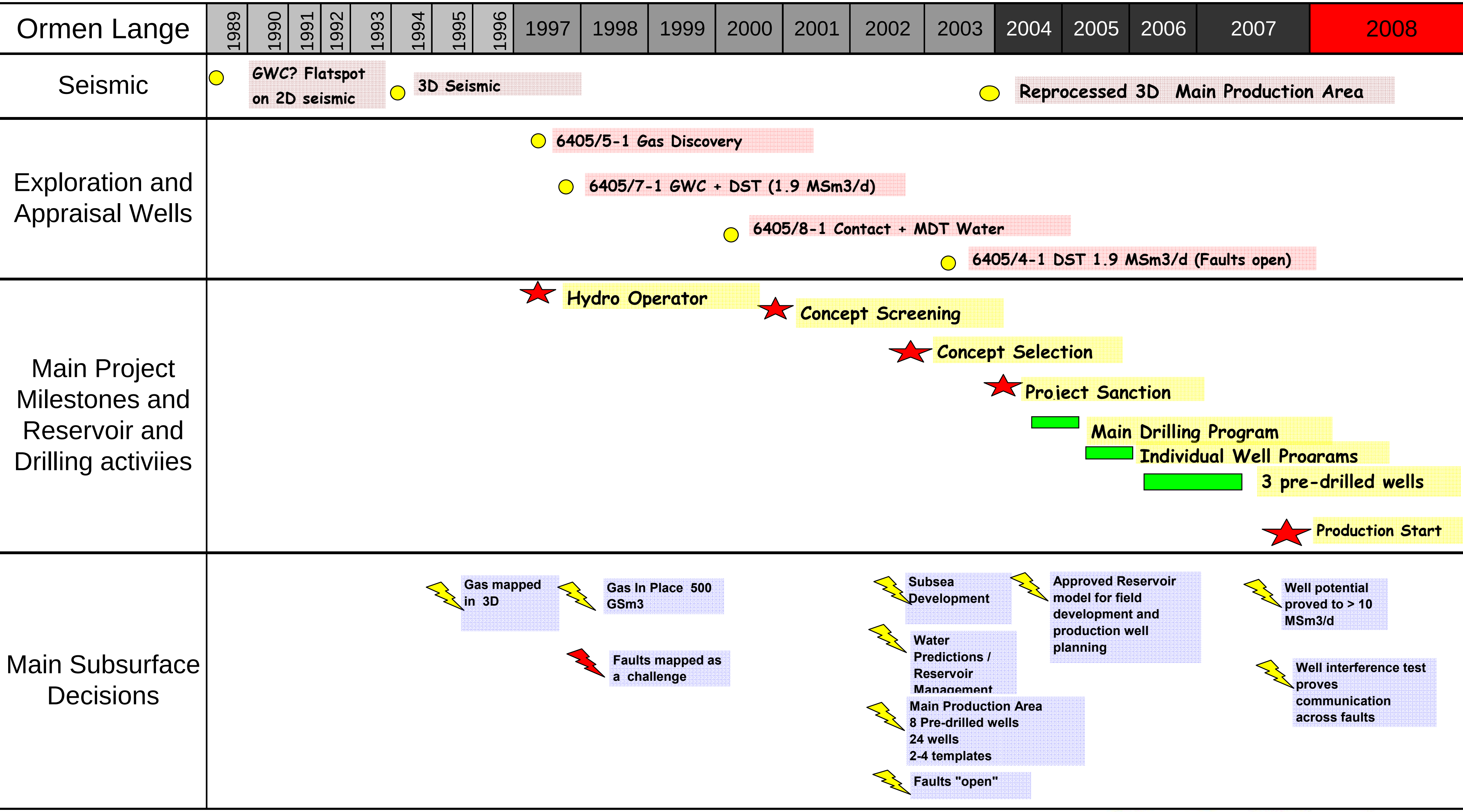
  Mu = 0.024cp

- **Distance Between wells**
  - **A7-A2A 2,218m**
  - **A7-A3 2,435m**
  - **A2A-A3 1,180m**





Ormen Lange Exploration, appraisal and development plan



Opening of Ormen Lange Saturday October 6, 2007