PRM on Johan Sverdrup - an unique Opportunity

Force seminar 2017 – Stavanger, Maximilian Schuberth

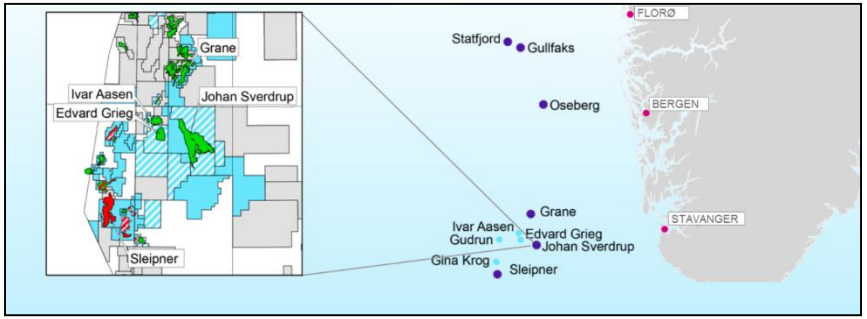
Agenda

- Introduction to the Johan Sverdrup Field
- Ambition for a world class recovery rate
- Permanent Reservoir Monitoring (PRM) on JS – an unique opportunity
- Summary

Introduction to Johan Sverdrup

License Partners:

- Statoil (Operator) 40.0267 %
- Lundin Norway 22.6 %
- Petoro 17.36 %
- Aker BP 11.5733 %
- Maersk 8.44 %



General

Reservoir apex	~1800 m
Water depth	~110 m
OWC	1922 - 1934 m MSL
Pressure	Hydrostatic
Thickness	4 – 146 m (Well Observation)
Age	Late Triassic to Early Cretaceous

Reservoir Facts

Quality	25-30 % Porosity, High NTG Multi Darcy permeability No gas cap
Area/Volume	~200 km^2 area Recoverable volumes 2 – 3 bbl

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Johan Sverdrup
- the giant value creator

TOP 5	70 %	50 YRS.	2 – 3 bn	660 000
One of the largest oil fields ever on the NCS	Ambition - recovery	Production horizon	Resources bbl	Production capacity bopd

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Johan Sverdrup
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70 %

Ambition - recovery

Drainage Strategy

Water Flooding

IOR Projects

WAG Injection
Infill Drilling
Potential advanced IOR methods

Reservoir Surveillance

PRM
Well Monitoring

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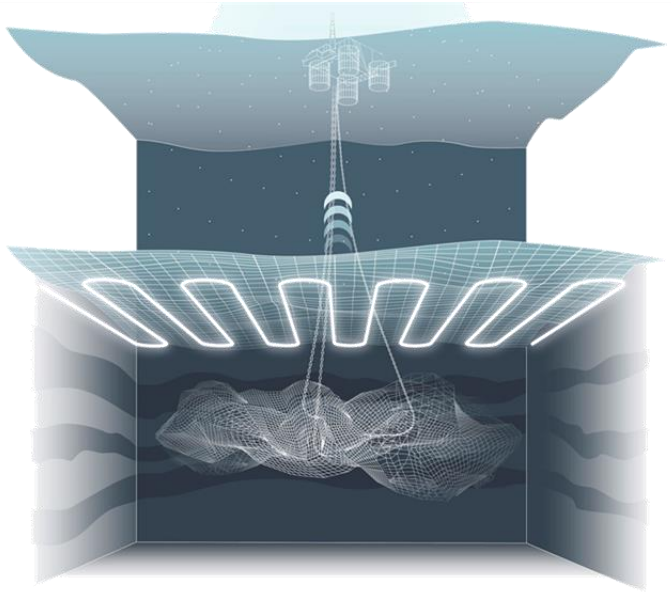
Reservoir Surveillance

Geophysical reservoir monitoring is part of the overall field surveillance and drainage strategy.

Permanent seismic cables will be installed on the seafloor.

PRM is the optimal solution, allowing:

- High Quality
- Flexibility
- Short Turnaround



Time lapse Concept

Base

Monitor

Pictures from Sascha Bussat, Statoil

Time lapse Concept

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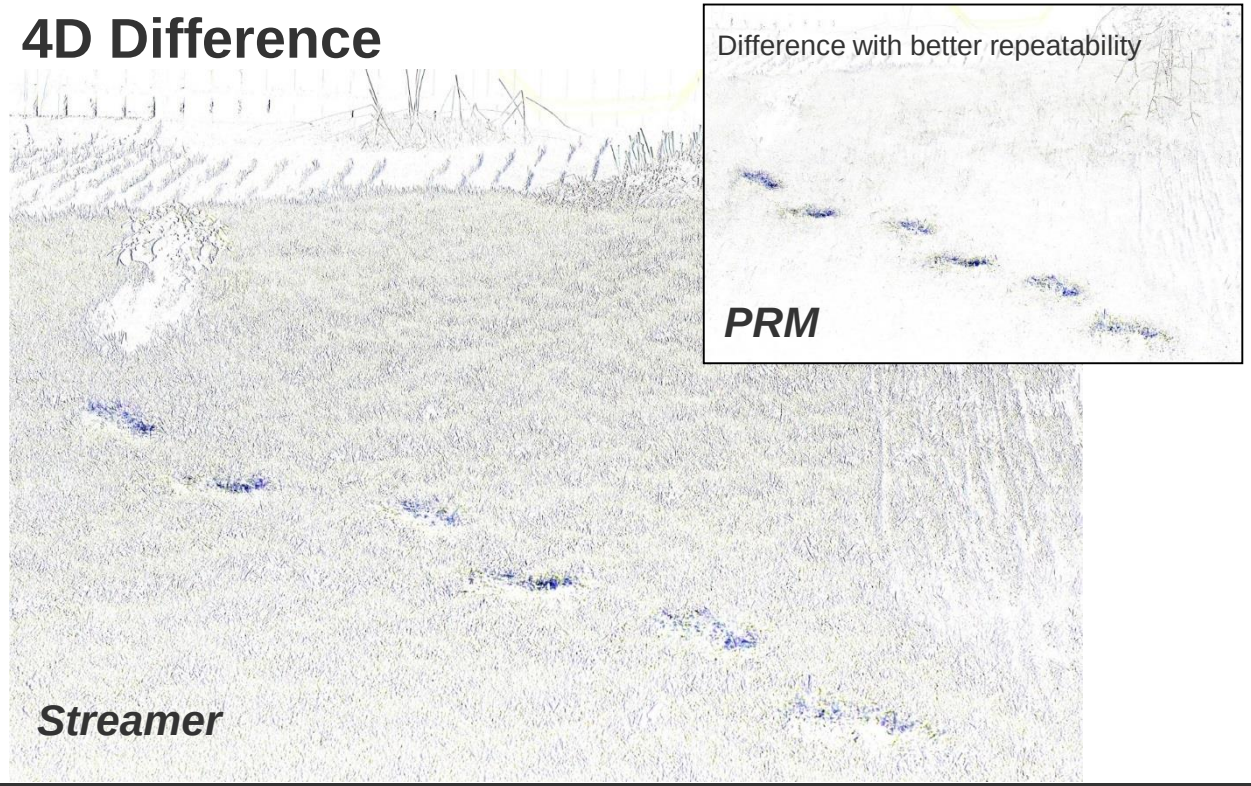

Pictures from Sascha Bussat, Statoil

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Time lapse Concept

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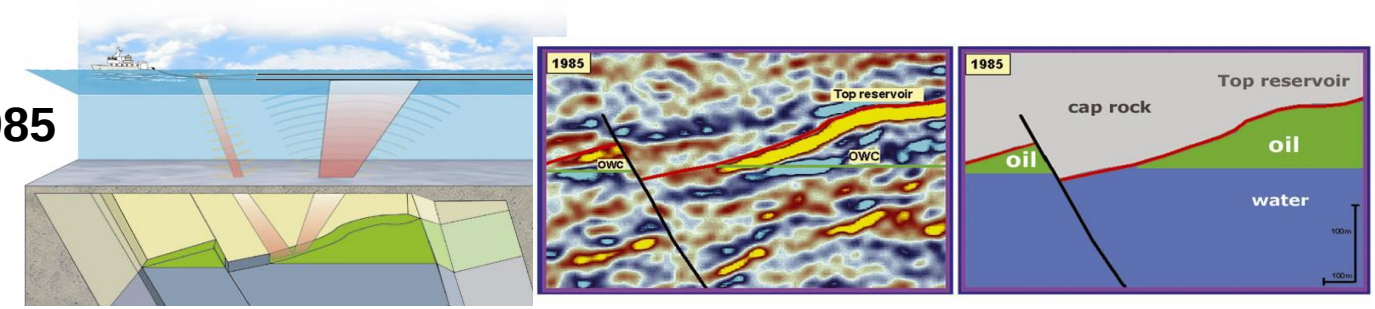

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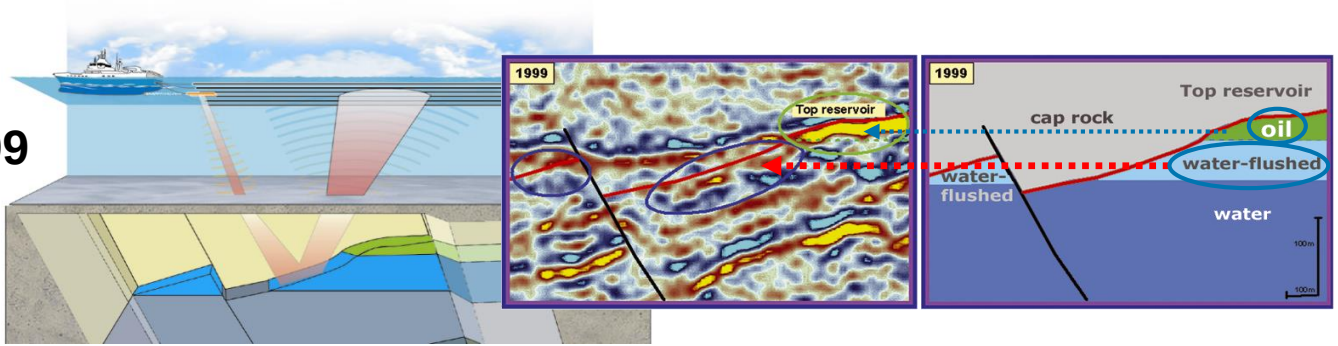

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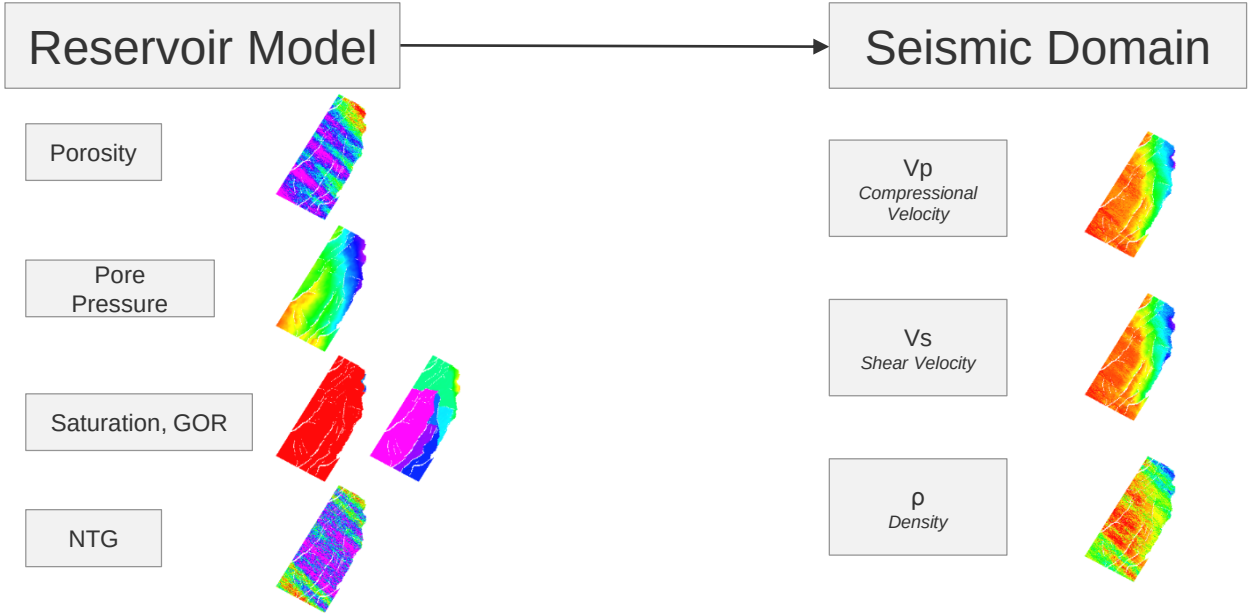
Feasibility – Petro-Elastic Modeling

Converting reservoir properties to elastic rock properties



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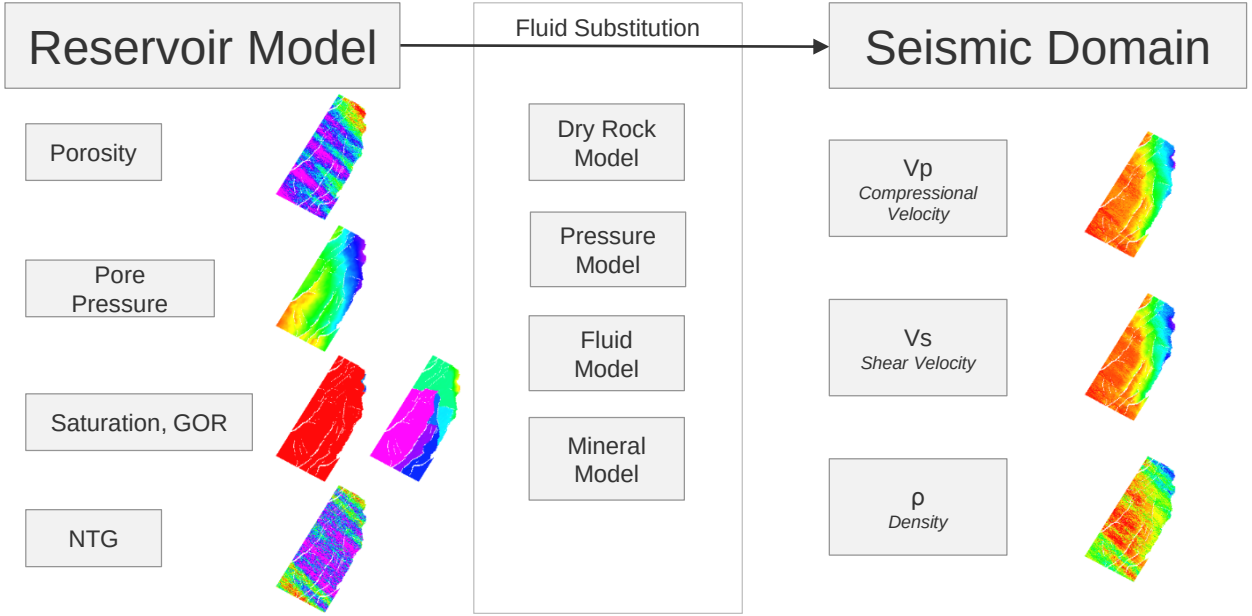

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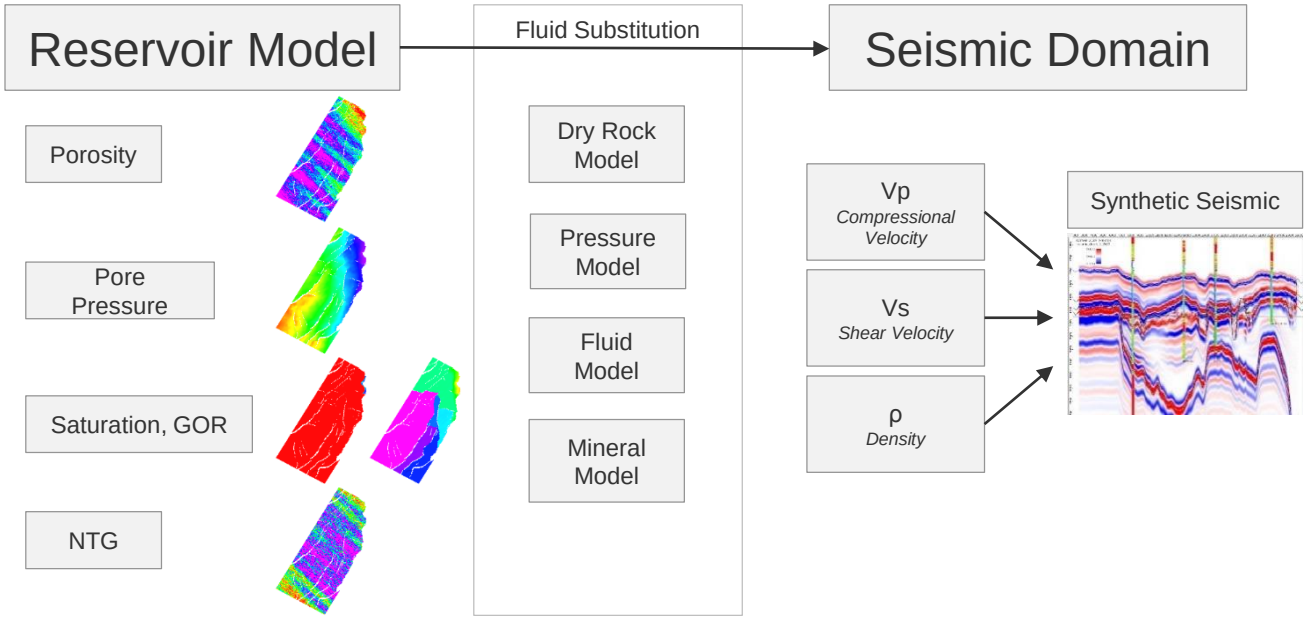

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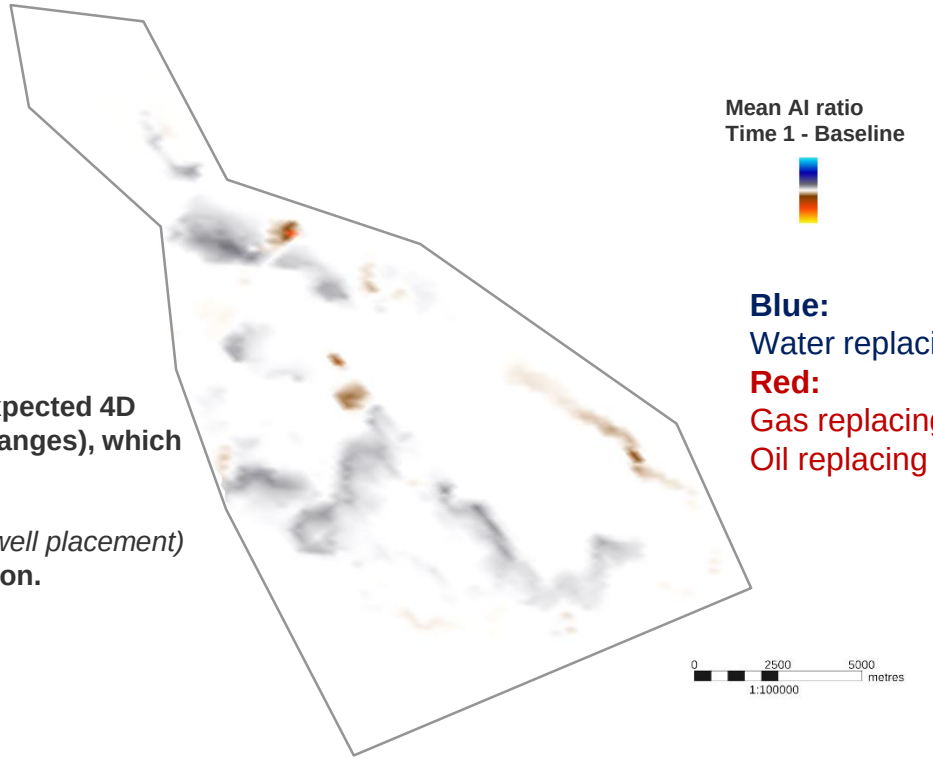

Blue:
Water replacing Oil /Gas
Red:
Gas replacing Water/Oil
Oil replacing Water

PEM provides a way to model expected 4D effects (or seismic amplitude changes), which can be used as input to:

- **survey design,**
- **hypothesis testing** *(e.g. IOR, well placement)*
- **and ultimately model calibration.**

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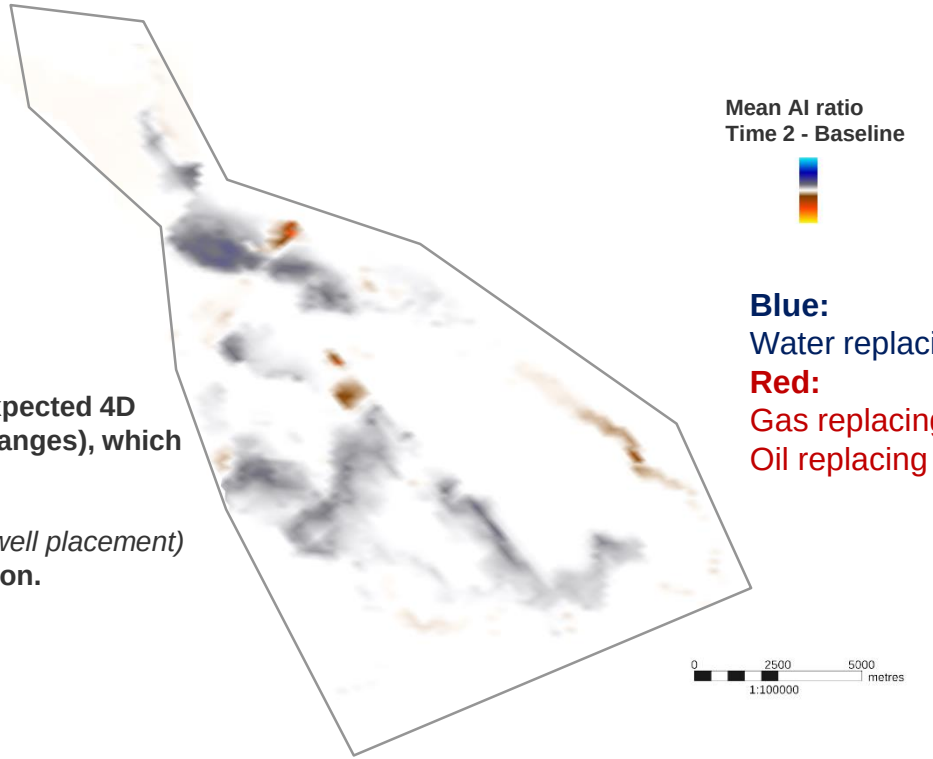

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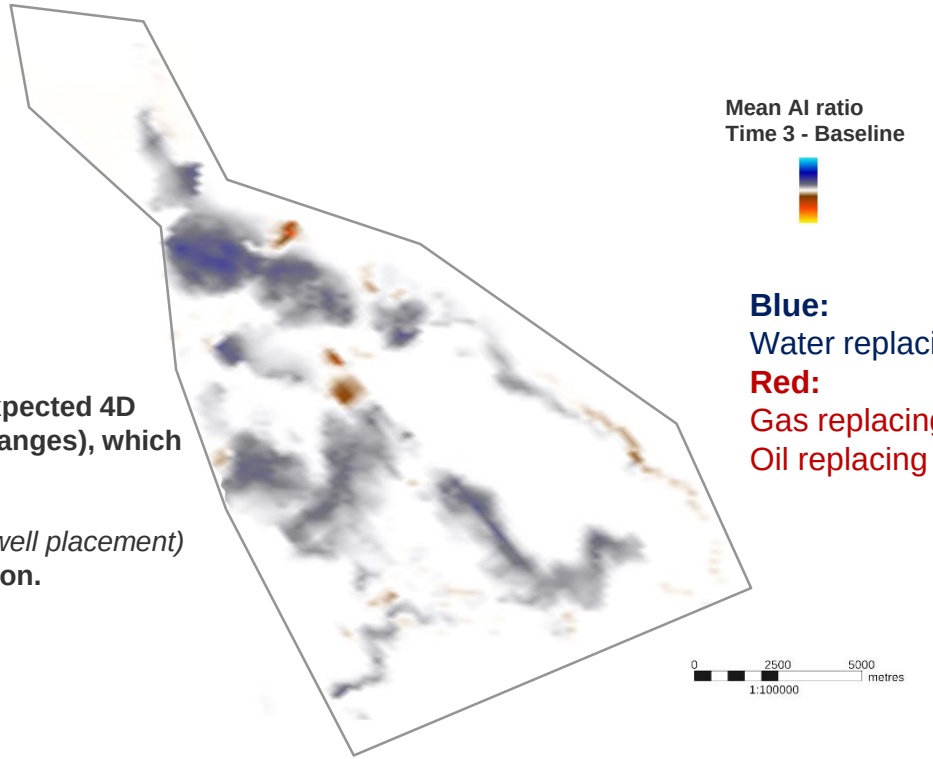

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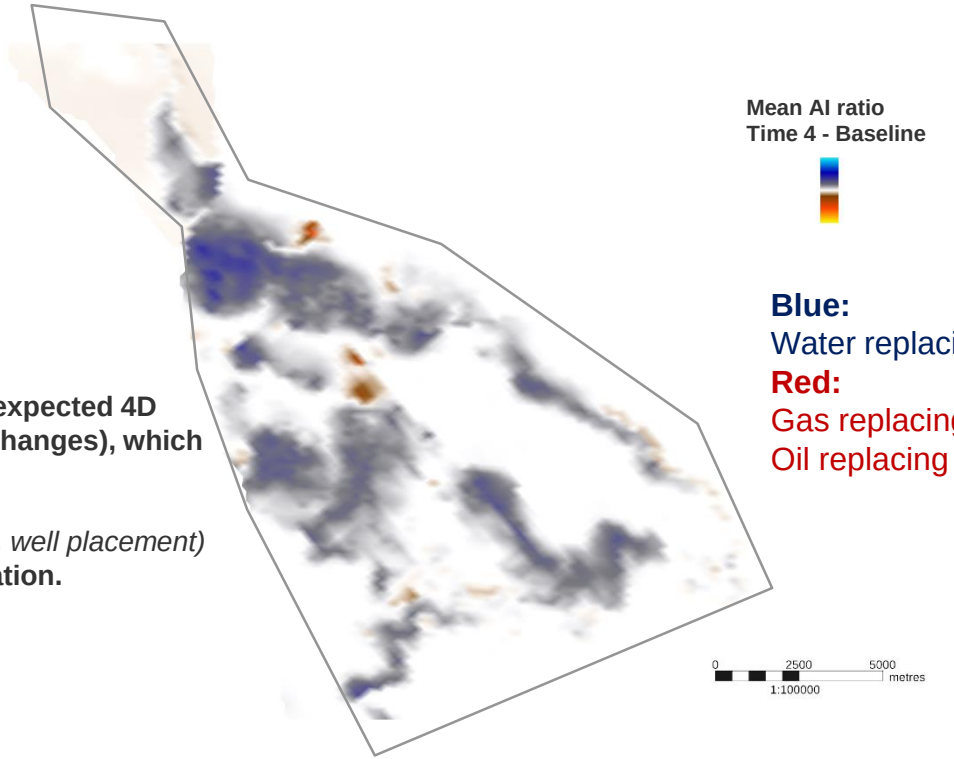

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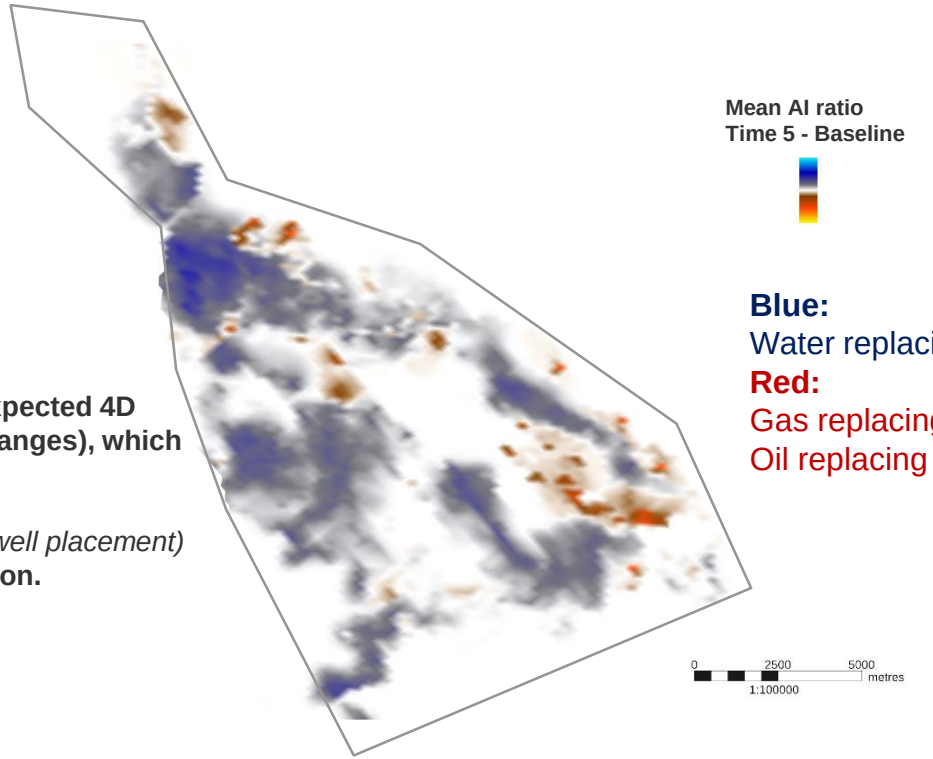

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Defining a PRM Layout

Aspects controlling the layout of the PRM system.

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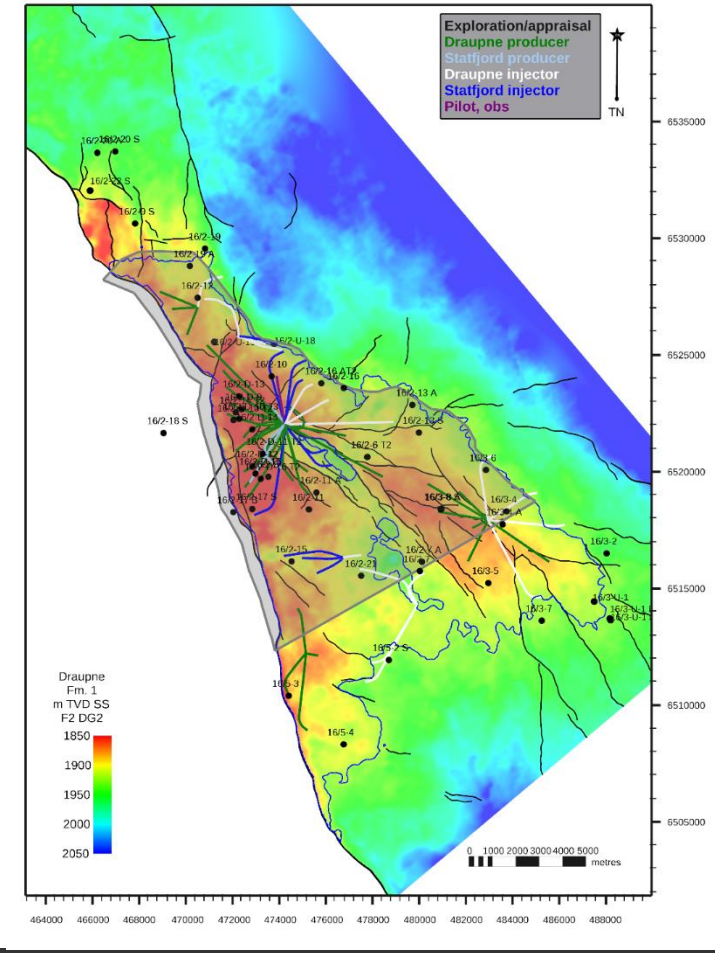
PRM Layout

- Total field area about 200 km^2
- PRM outline 125 km^2
  - 400 m cable separation
  - 335+ km of cable



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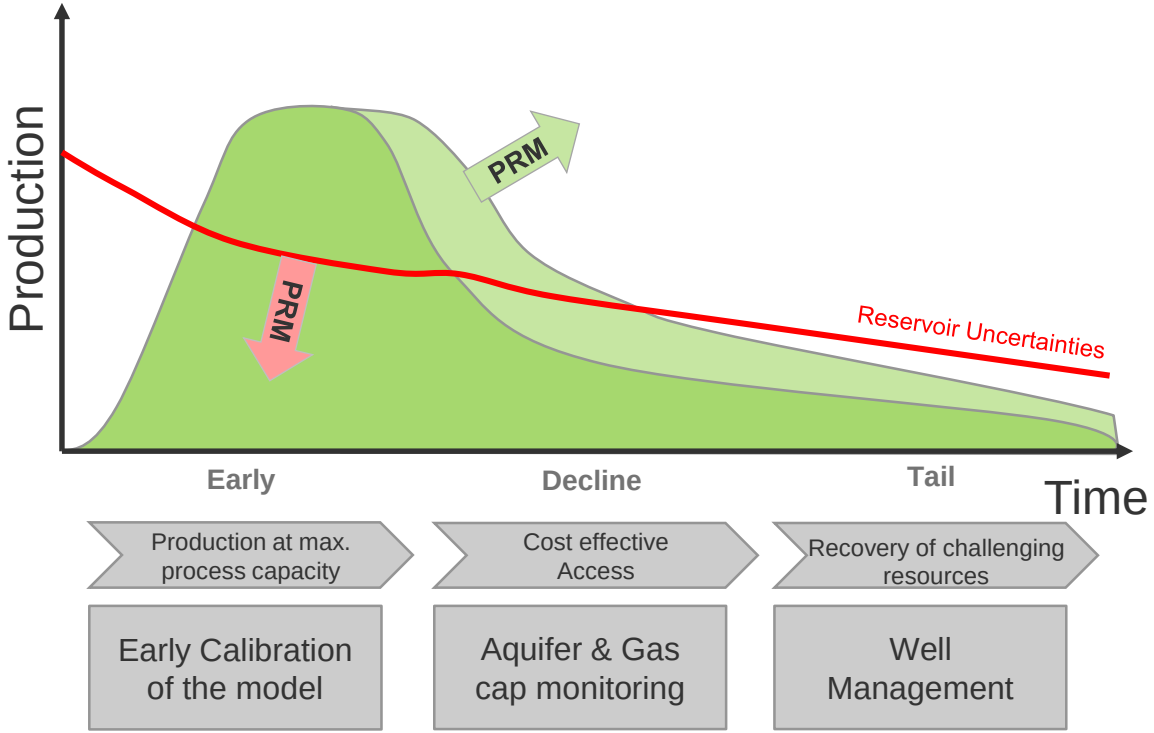
PRM on JS – An Unique Opportunity



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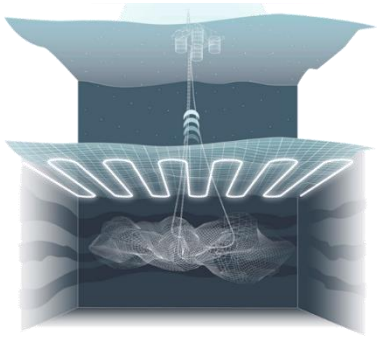
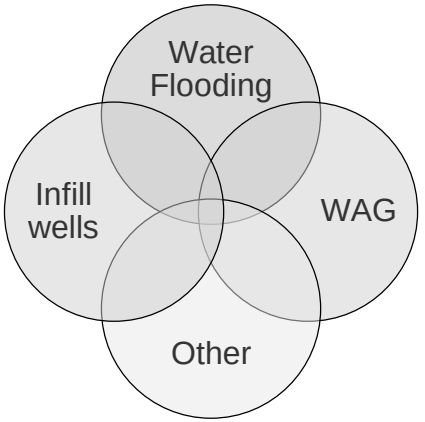


As a comprehensive monitoring solution, the PRM system on JS provides a link between IOR methods, and of course the general drainage.

It can monitor them alone and their interaction, throughout the life of the field.

Its various monitoring applications can provide an improvement for business cases of IOR methods.



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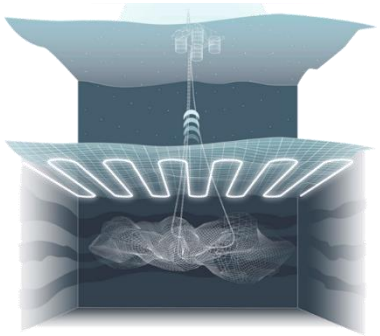
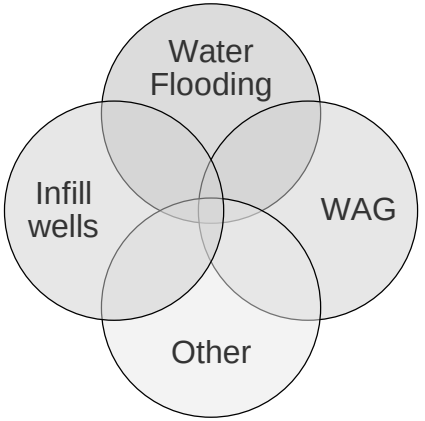


Possible applications include:

- Overburden Surveillance
- Seismic PLTs
- Production optimisation
- Well placement



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Summary

- Technical feasibility of the PRM system on Johan Sverdrup has been shown.
- Substantial efforts went into designing the areal coverage and cable spacing.
- The derived layout is a good balance between cost, monitoring focus areas and installation constraints.
- As a monitoring solution, it can positively contribute to the business cases of IOR methods.
- Through monitoring, PRM contributes to IOR effectiveness, thus can ultimately be considered an IOR method itself.

Thank you!

We also thank the partners for permission to present this work:

Lundin Norway petoro AkerBP MAERSK OIL Statoil

Statoil. The Power of Possible

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Maximilian Schuberth, Statoil

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