



NORWEGIAN PETROLEUM
DIRECTORATE

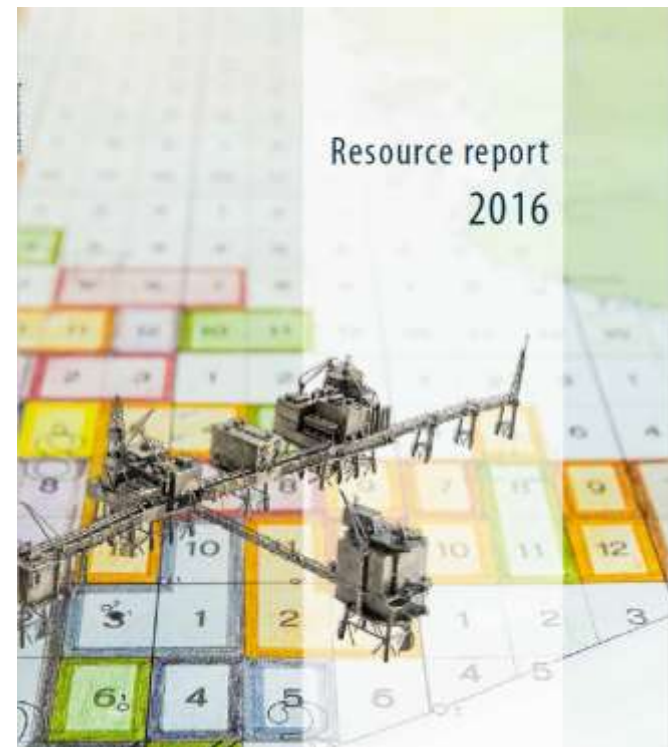
YTF – statistical analysis of 1700 prospects and leads

Gunnar V. Søliland

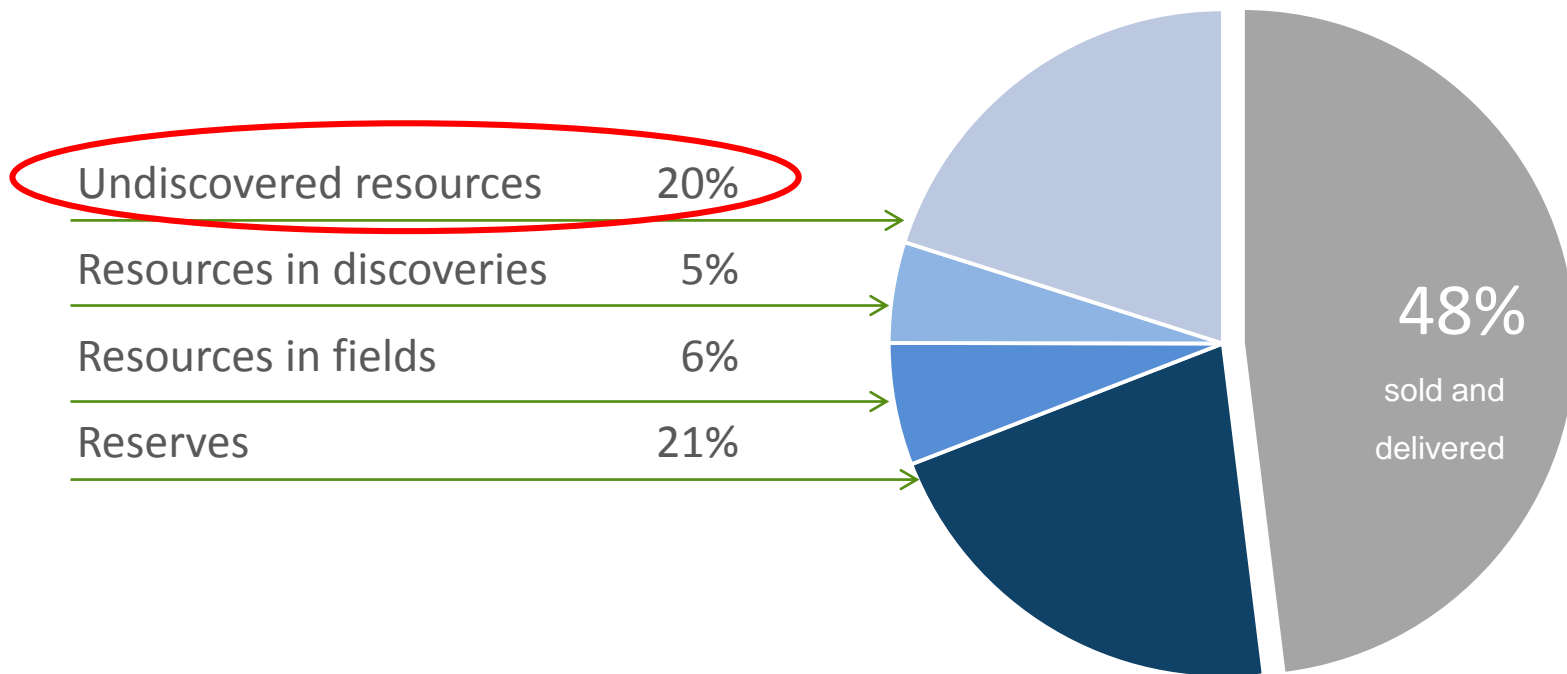
Norwegian Petroleum Directorate

Norway's Petroleum Resources

- The Norwegian Petroleum Directorate (NPD) is responsible for maintaining a complete inventory of petroleum resources in Norway.
- This is done in accordance with established resource classification routines, regular reporting from the oil companies and NPD's geological mapping.
- NPD compile and publish annually figures on field reserves, contingent resources and YTF resources.



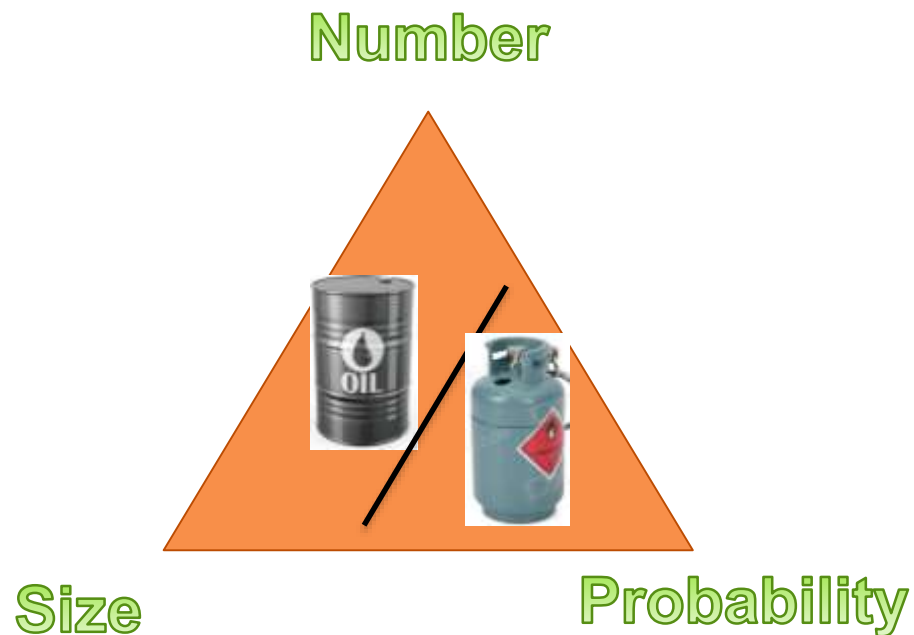
More than half of the resources still remain



Estimating Undiscovered, Yet To Find (YTF) Volumes

$$\text{YTF} = \text{Number of prospects} \times \text{Size} \times \text{Probability}$$

Probability of oil/gas (HC phase)





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1: Number of Accumulations



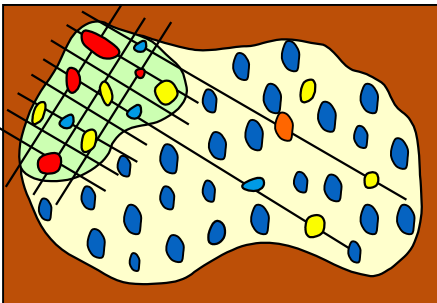
Number of features / feature density

Assessment of feature density is based on one or more calibration areas where all relevant elements can be counted.

These elements are the number of

- discoveries
- dry wells
- mapped prospects
- leads

+ number of postulated prospects (which could be mapped in the future).



NPD's Database

- Maintain Extensive Prospect database updated by
 - NPD in-house mapping
 - License Applications
 - Prospect mapping in the Licenses (Exploration committees / L2S)
 - Many Prospects are recorded with several historic estimates
- Pre-drill estimates compared to Well results – reported by the Operators
- All Discoveries and Fields – annual reporting from the Operators
- Complete well data base with all interpretations and reports

Norway – some numbers June 2017

903 Production Licenses signed

1764 Exploration Wells

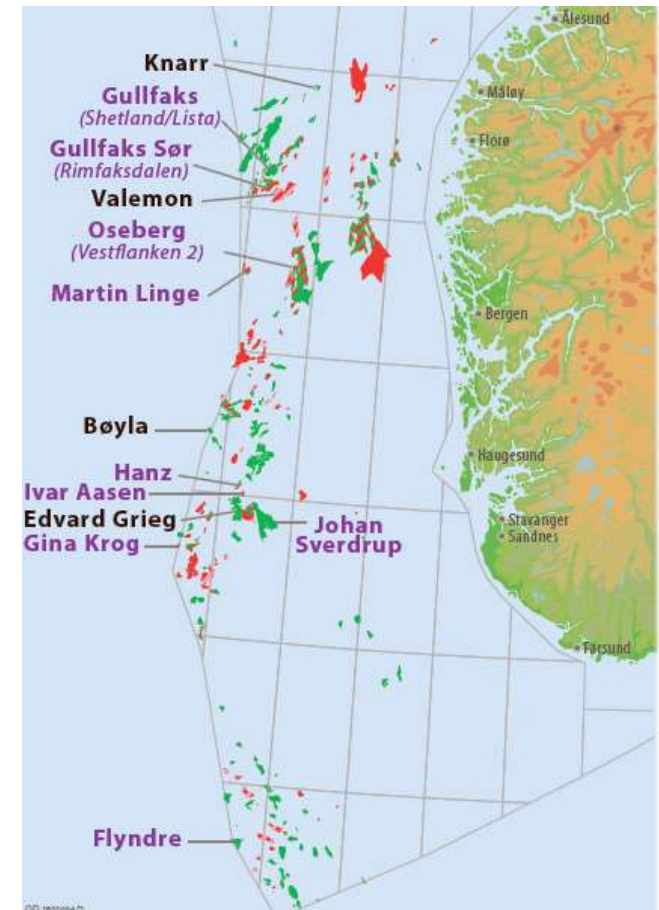
4553 Production / Injection Well

81 Fields in Production (116 fields totally)

1100 Prospects

600 Leads

74 Plays identified and analysed by NPD





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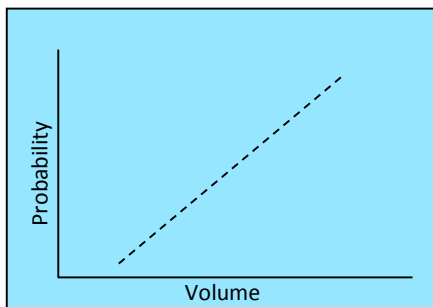
2: Size of future discoveries



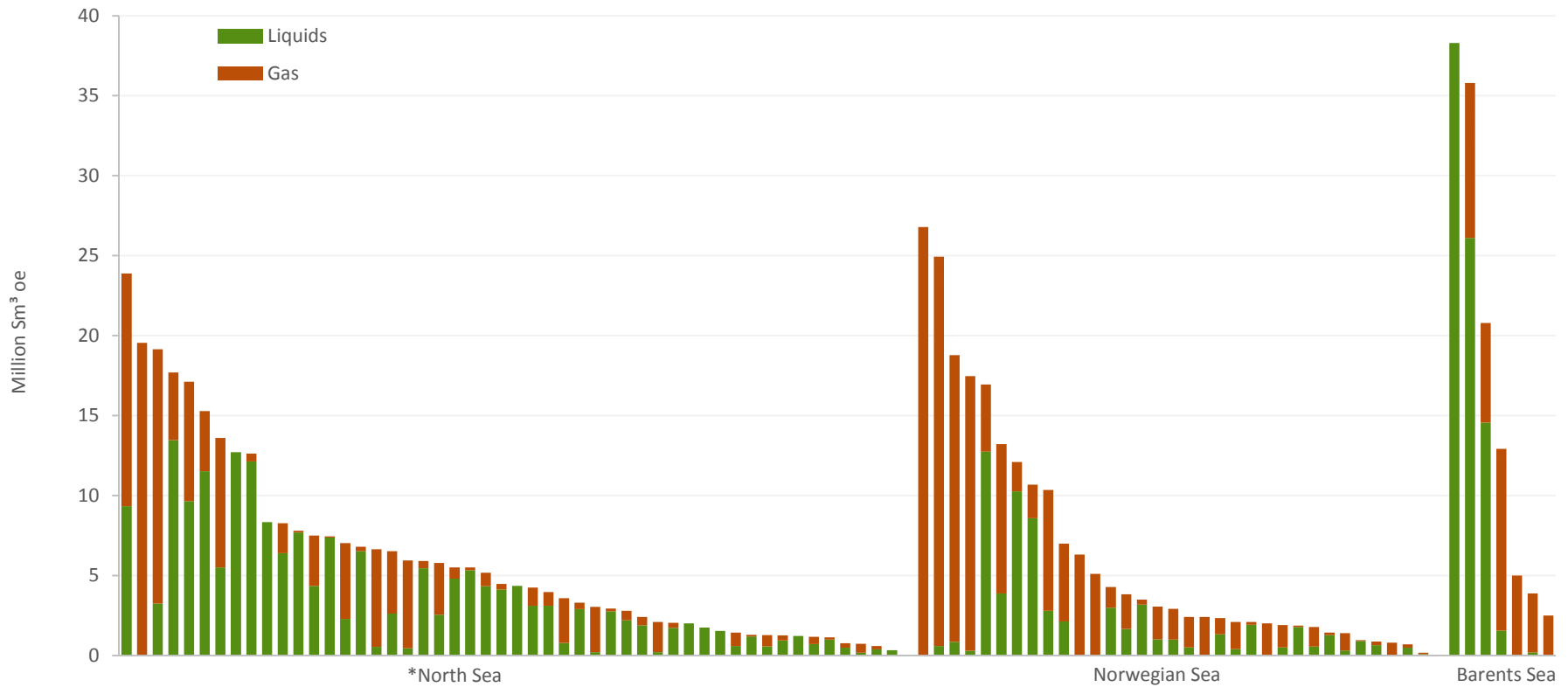
We think they are bigger than they are

Size of prospects and discoveries

1. Sizes of mapped prospects in the play.
2. Information from discoveries is important for confirmed plays. Knowledge of discovered volumes are essential for assessment in mature plays, while information from analogues is also important for less explored cases.
3. Calculating the size of future discoveries builds on estimates of volume and fluid (liquid and gas) parameters.

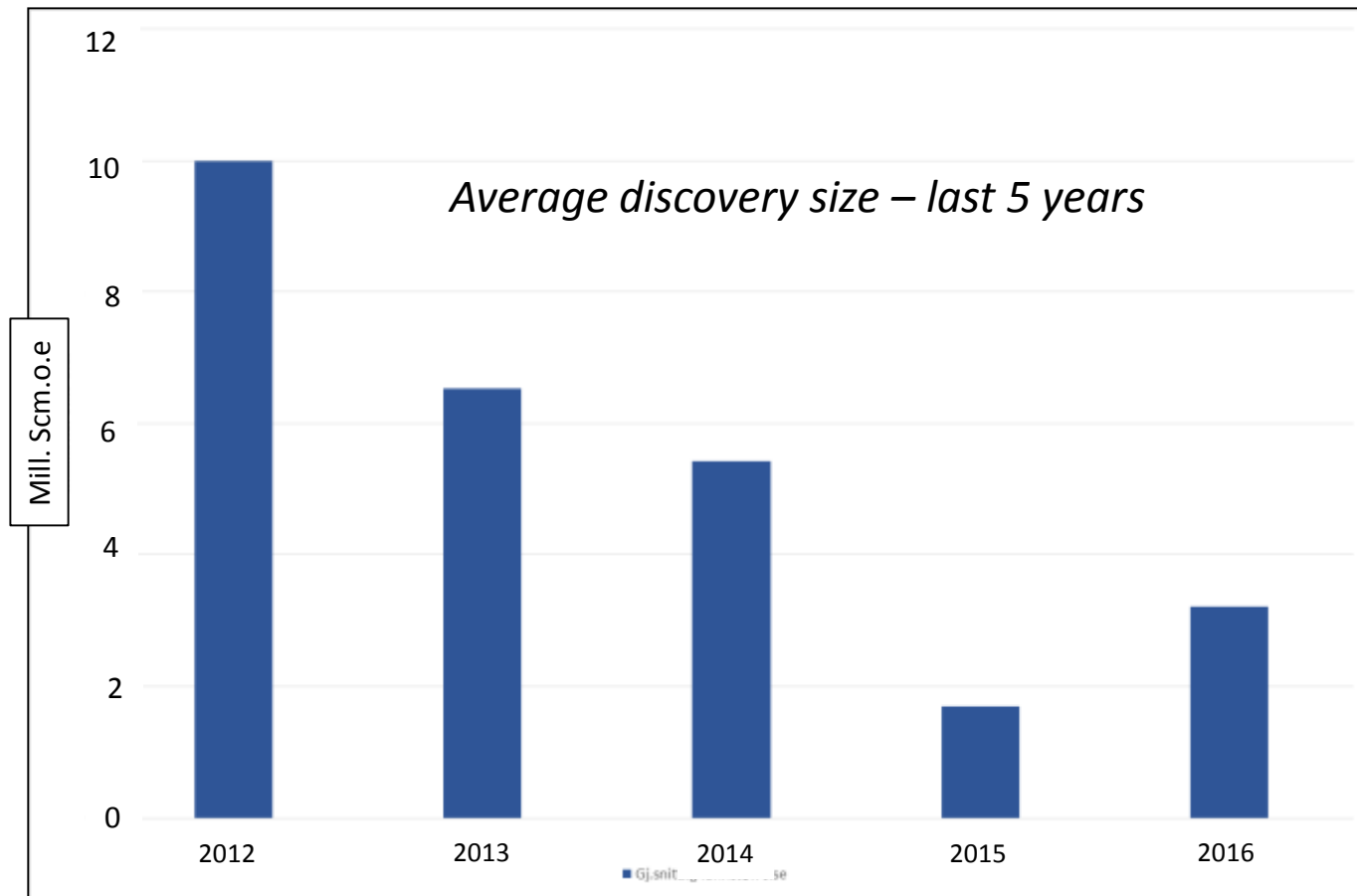


Discoveries last 10 years pr. region sorted by size

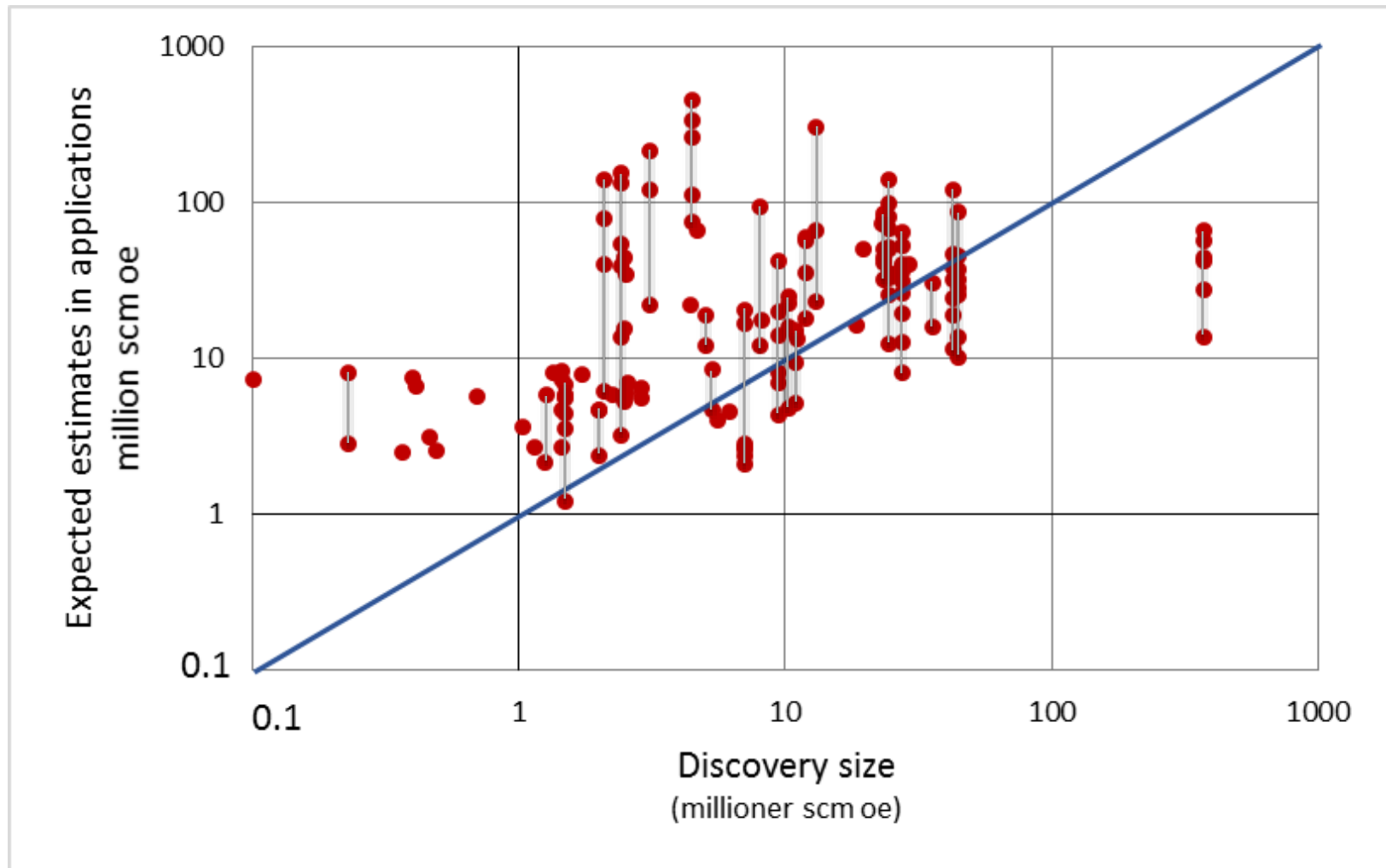


*Johan Sverdrup is not included.

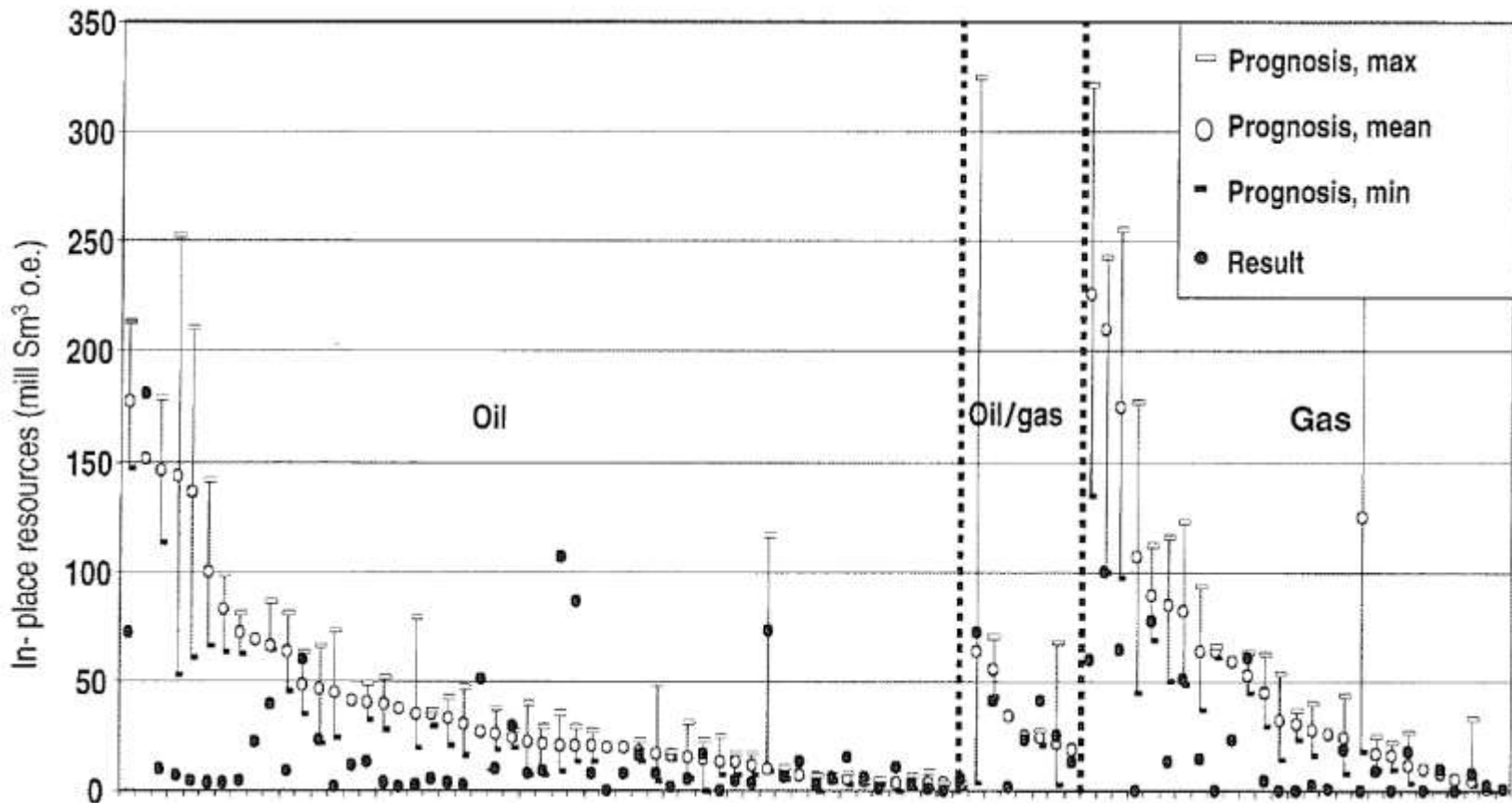
Smaller discoveries



Discovery size vs estimates in applications



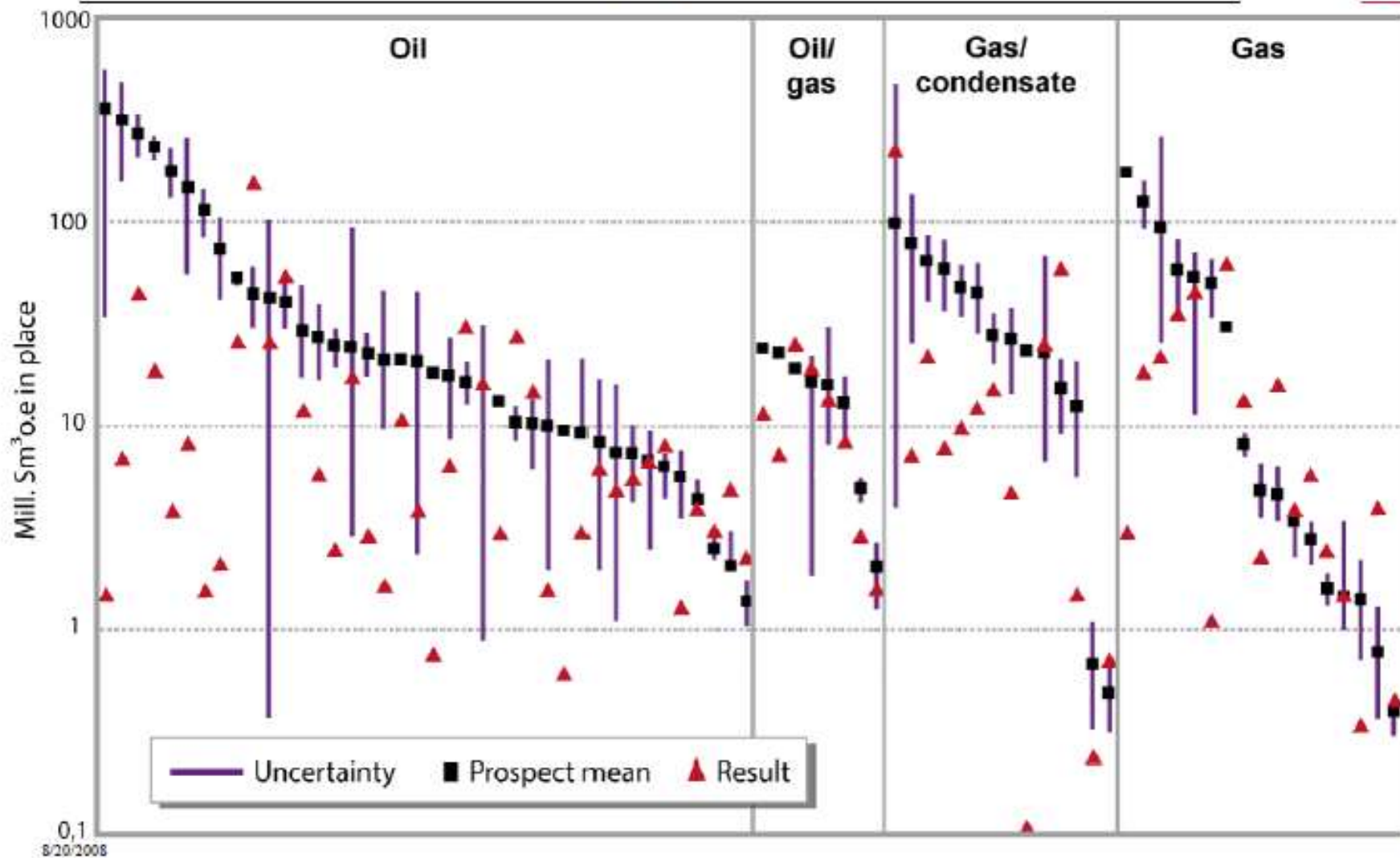
NCS Pre vs Post-drill volume estimates 1998



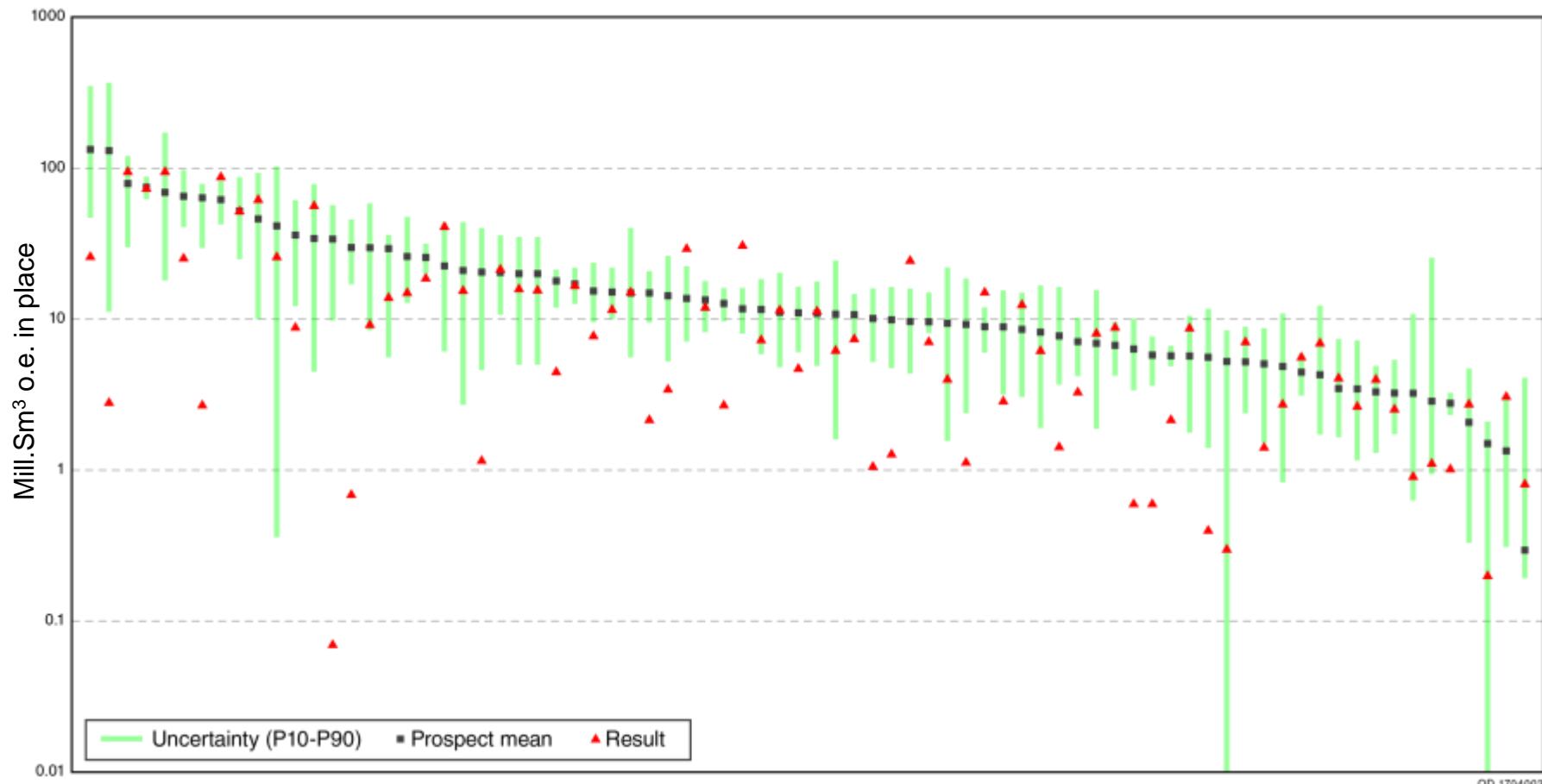
K.Ofstad et. al (1998) Evaluation of Norwegian Wildcat Wells

2008

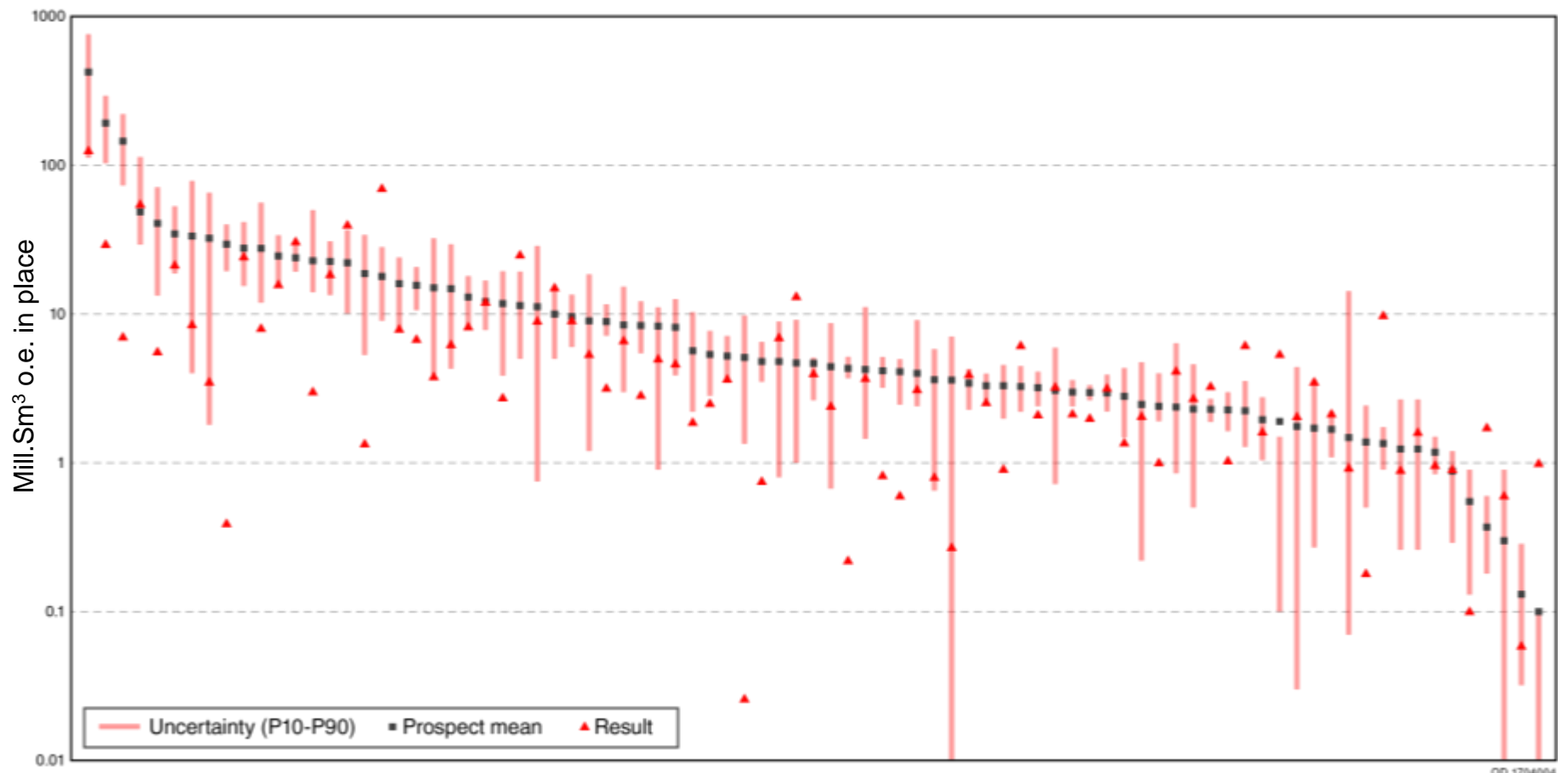
Discoveries ranked by prognosed resource estimates, sorted on prognosed HC - phases



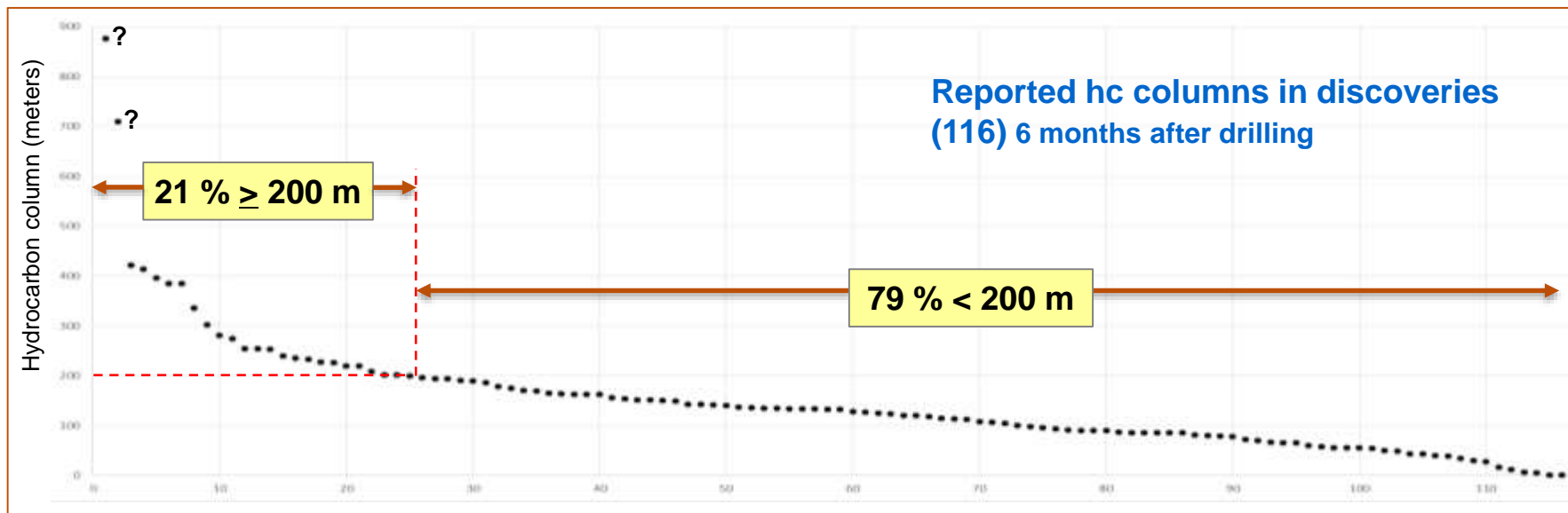
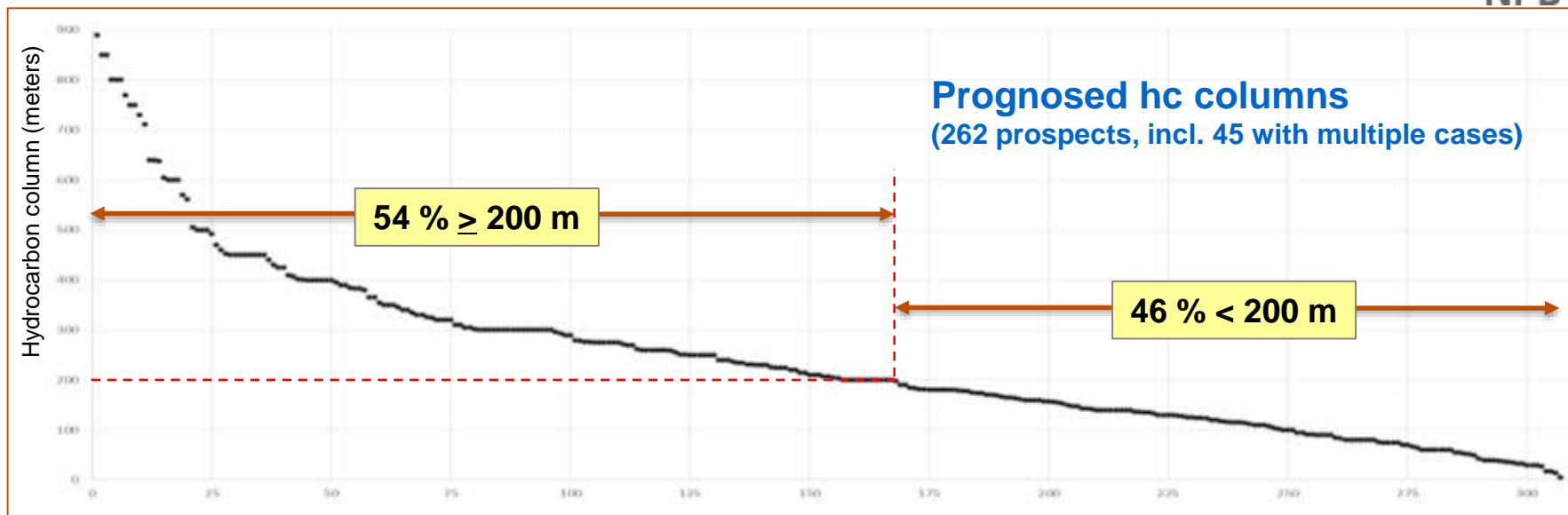
Exploration targets 2007-2016 - oil



Exploration targets 2007-2016 - gas



Hydrocarbon columns, Norwegian Sea 1990-2015. Prognosis vs. reported results (base case)





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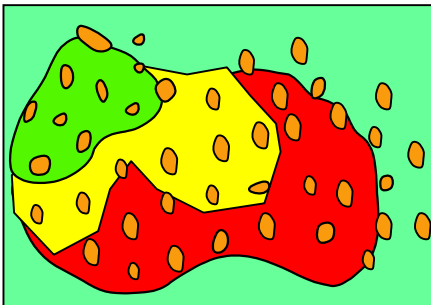
3: Probability of Success



Prospect Probability and Discovery Success

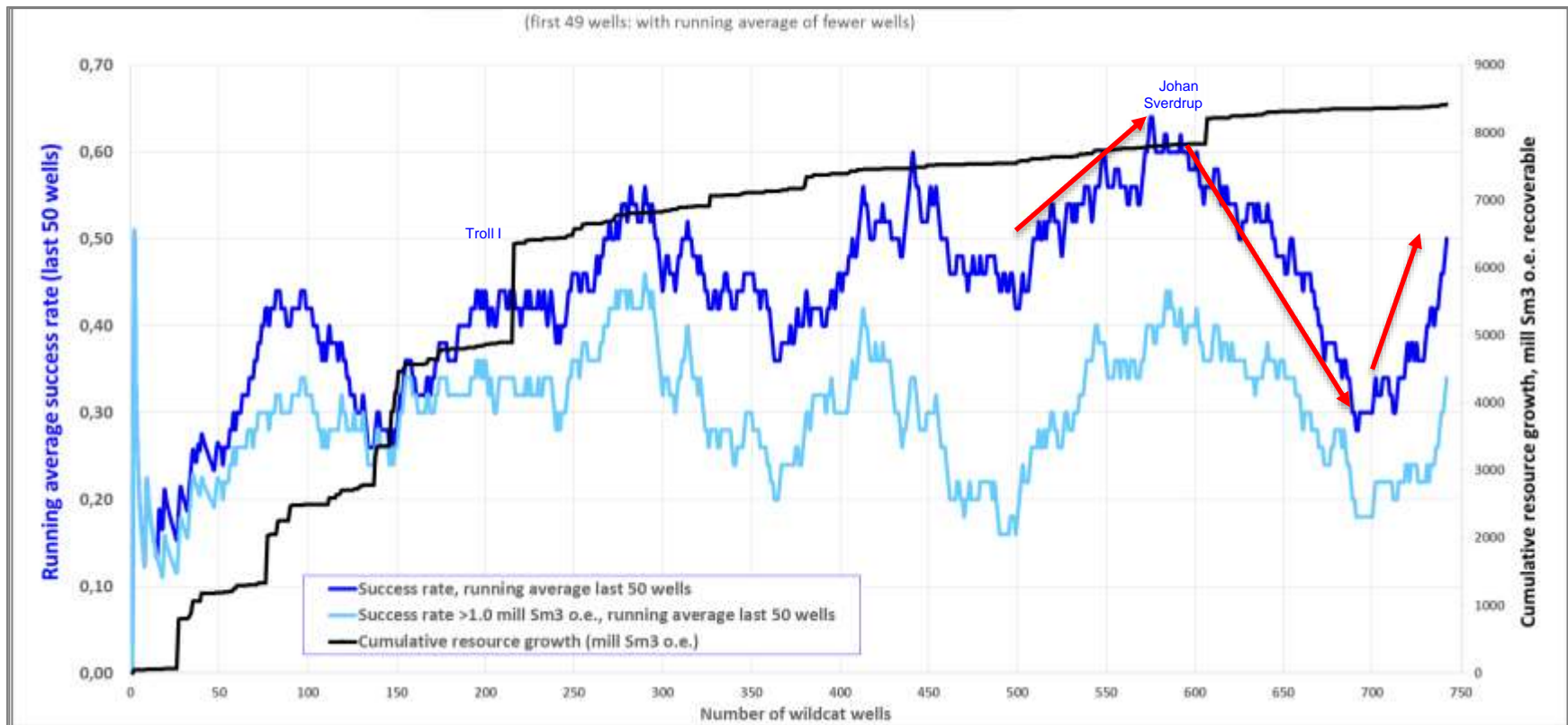
The probability of making future discoveries comprises the probabilities of a play being confirmed (play probability) and of a prospect becoming a discovery if the play is confirmed.

The historical finding rate for this and comparable plays is an important parameter.



North Sea – all plays. Success rate and resource growth 1966-2016

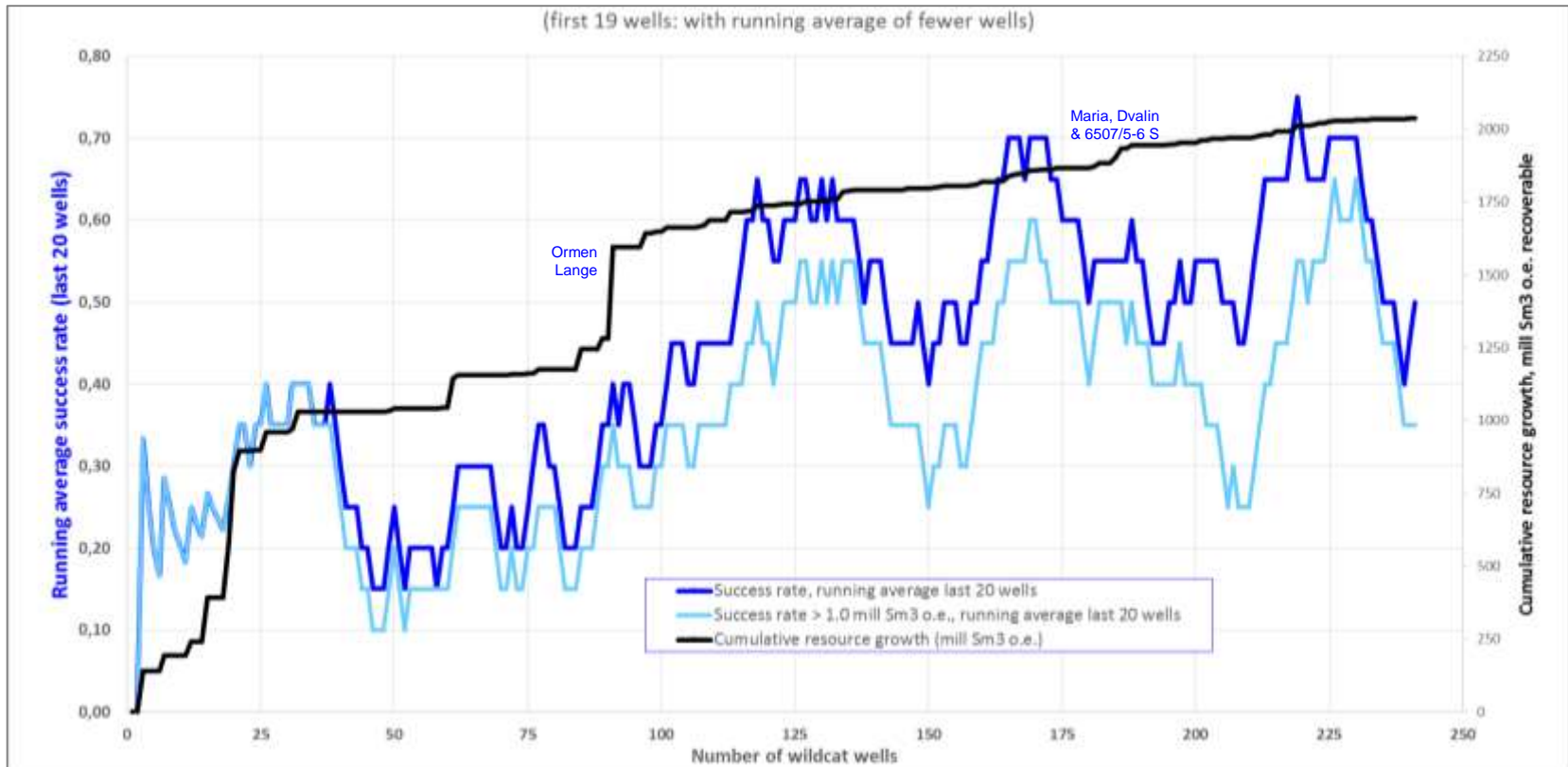
Running average success rate of last 50 wells – total and for discoveries > 1 mill. Sm³ o.e.



The last 50 wells - average success rate of 50%.

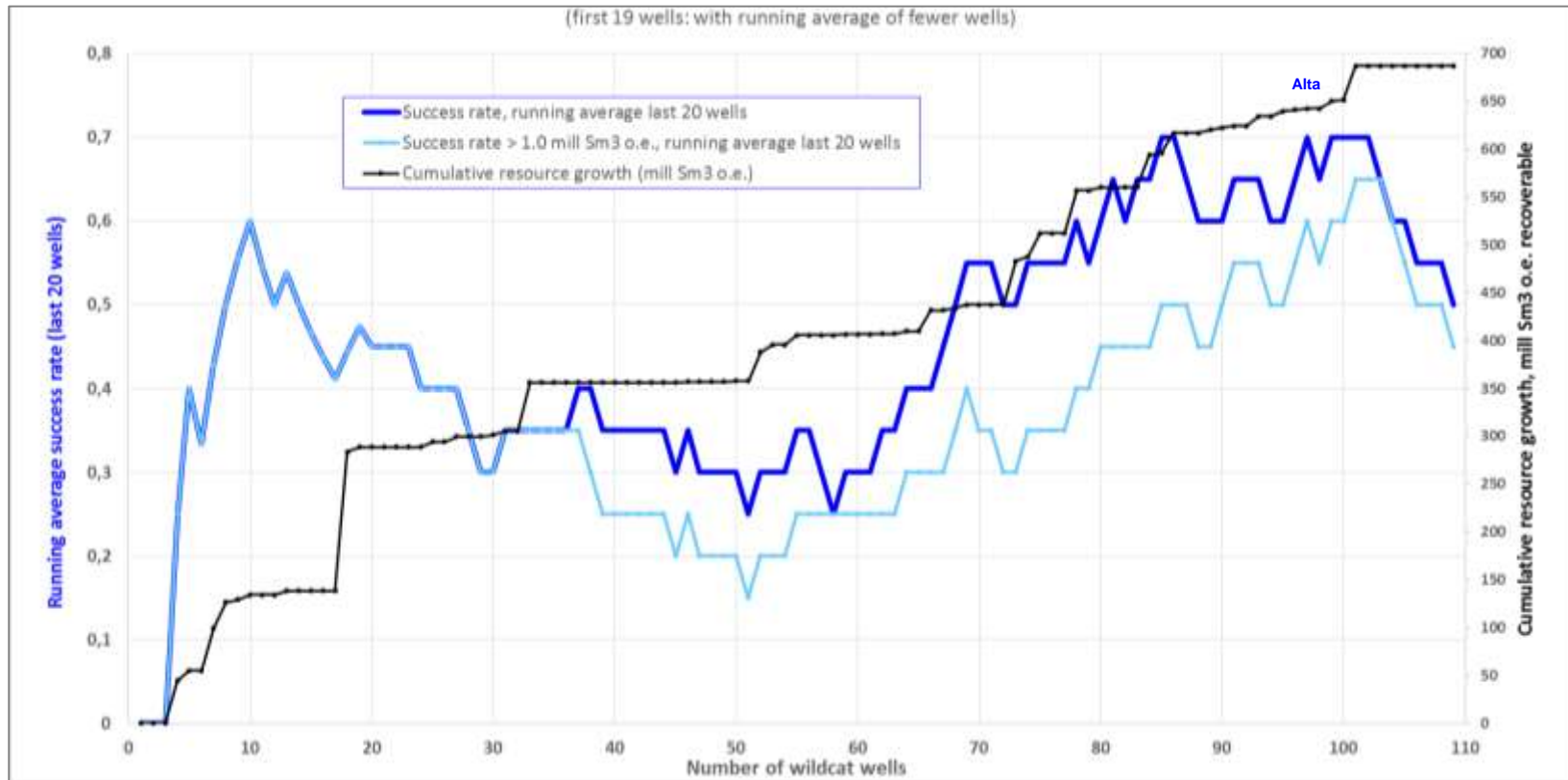
Norwegian Sea – all plays. Success rate and resource growth 1980-2016

Running average success rate of last 20 wells – total and for discoveries > 1 mill. Sm³ o.e.



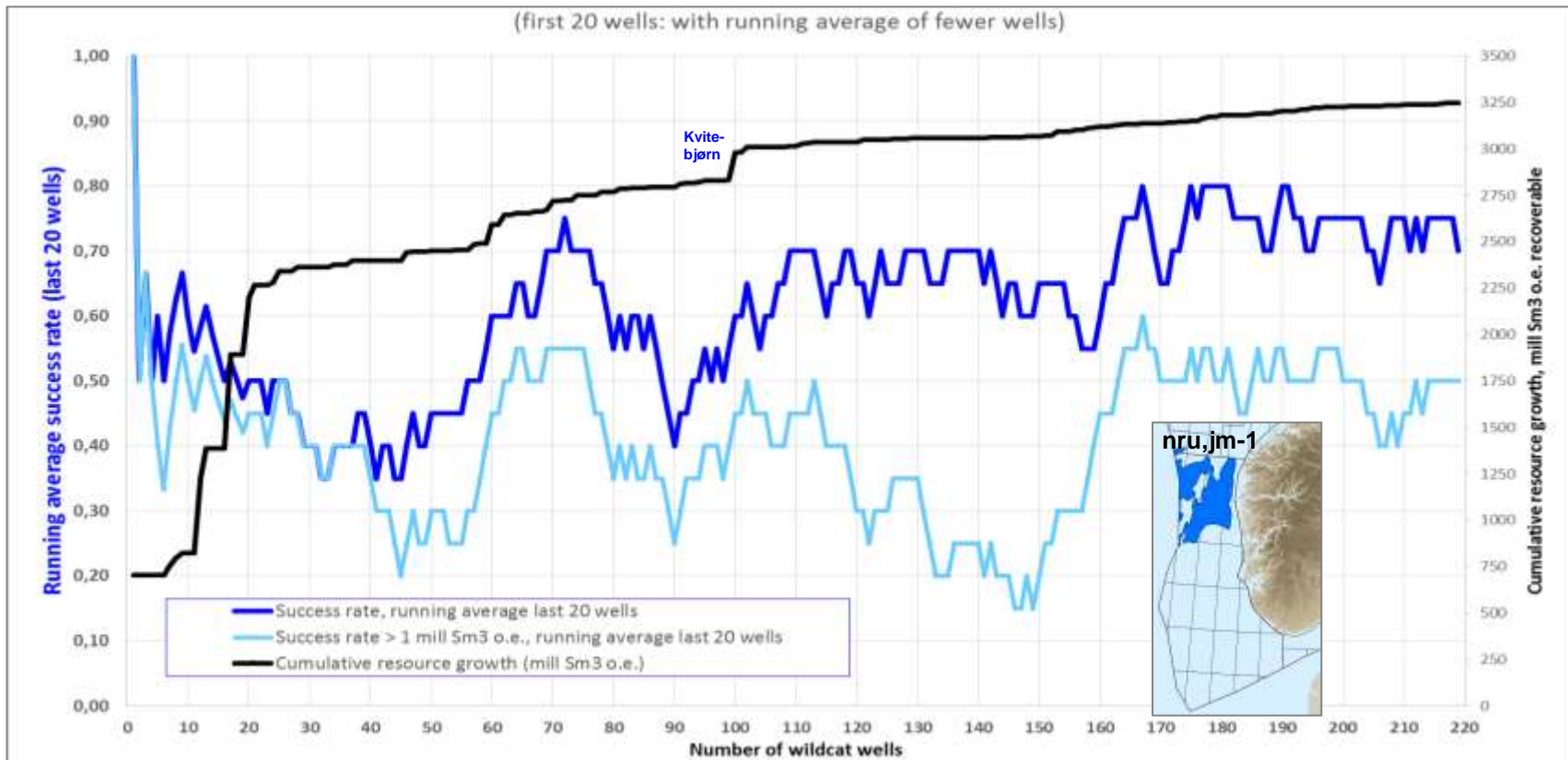
Barents Sea – all plays. Success rate and resource growth 1980-2016

Running average success rate of last 20 wells – total and for discoveries > 1 mill. Sm³ o.e.



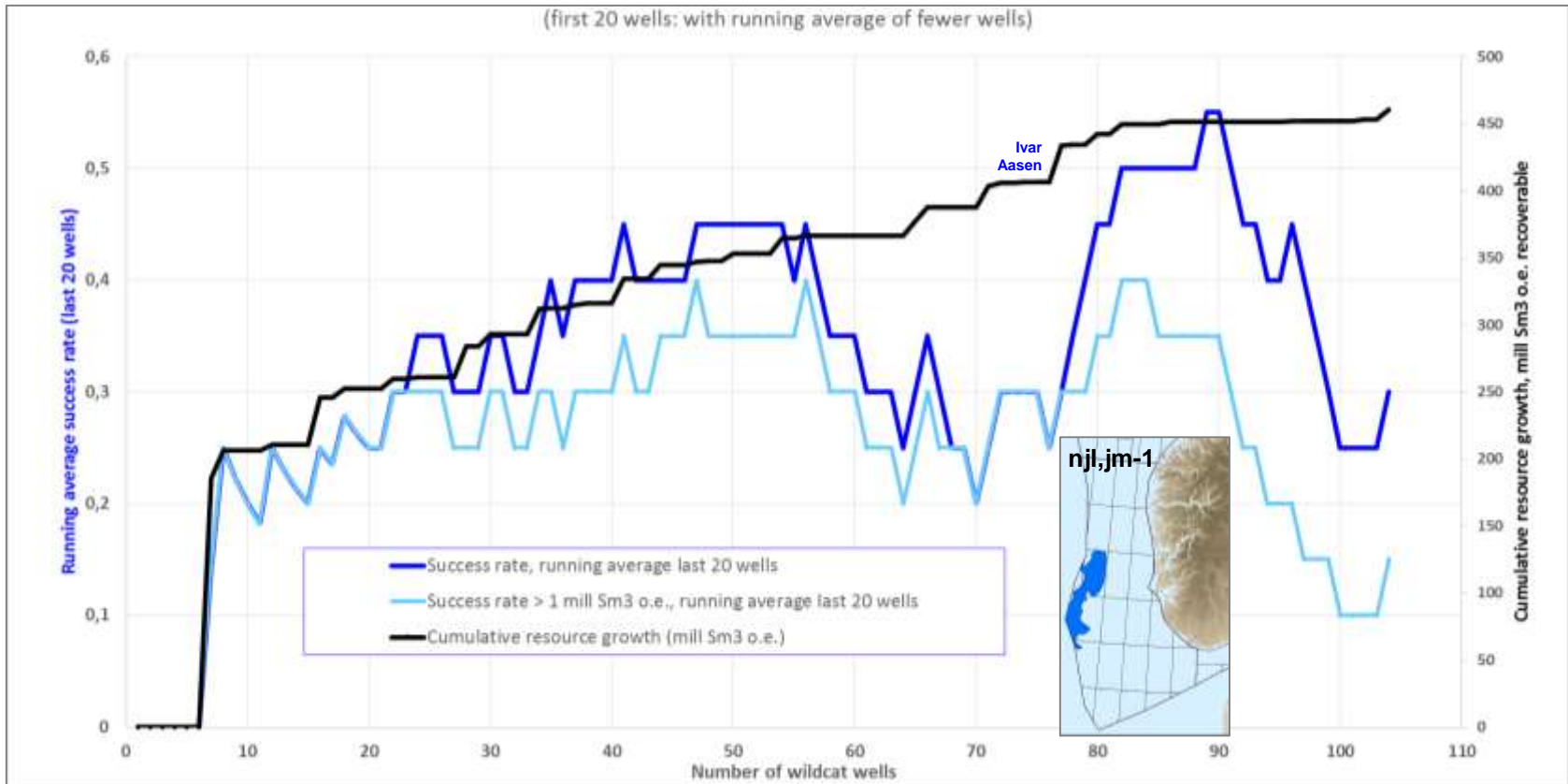
NPD play nru,jm-1: U. Triassic - M. Jurassic, Northern North Sea. Success rate and resource growth

Running average success rate of last 20 wells – total and for discoveries > 1 mill. Sm³ o.e.



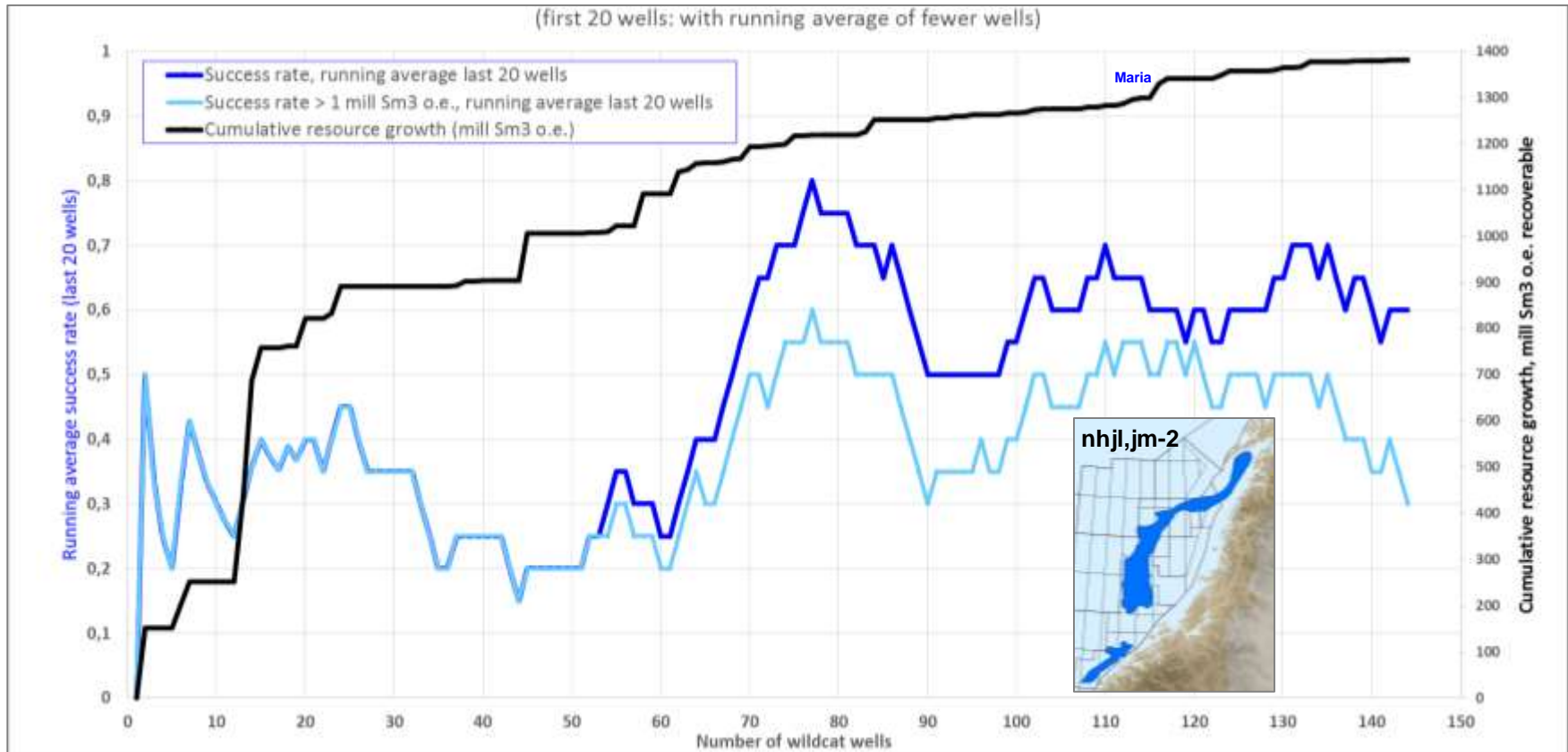
NPD play njl,jm-1: Late Triassic – Middle Jurassic, North Sea. Success rate and resource growth.

Running average success rate of last 20 wells – total and for discoveries > 1 mill. Sm³ o.e.



NPD play nhjl,jm-2: Late Triassic – Middle Jurassic, Norwegian Sea. Success rate and resource growth

Running average success rate of last 20 wells – total and for discoveries > 1 mill. Sm³ o.e.

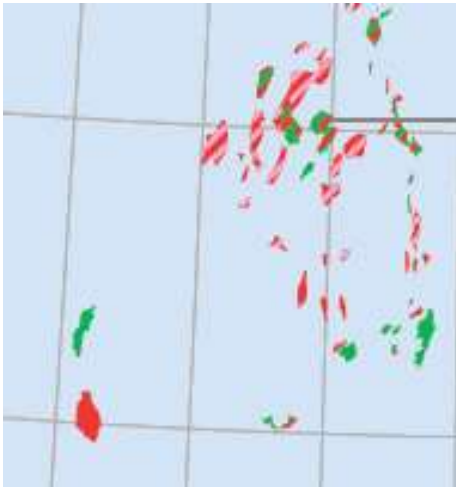


4: Probability of phase petroleum

Evaluations of source rock and migration are used initially to assess the probability of proving

- oil
- gas
- combination of both (multiphase discovery).

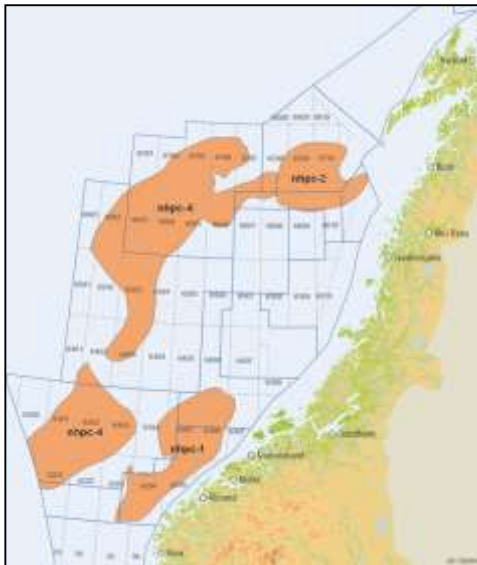
Information from the history of discoveries is very important for assessment in mature areas.



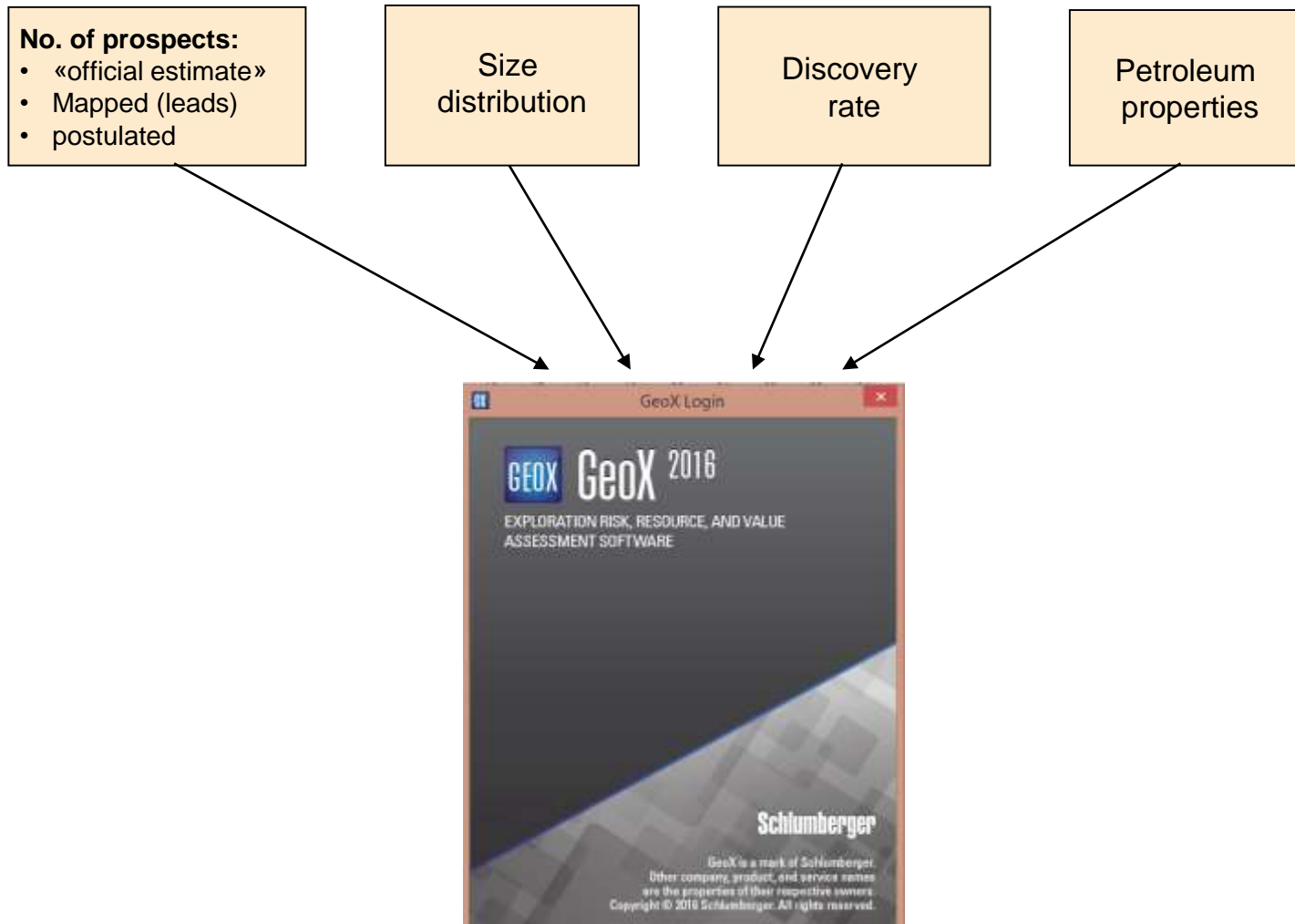
Plays on the Norwegian Continental Shelf

	Total	Confirmed	Unconfirmed
North Sea	24	20	4
Norwegian Sea	21	12	9
Barents Sea	29	12	17
Total	74	41	33

Examples of some plays in the Norwegian Sea:



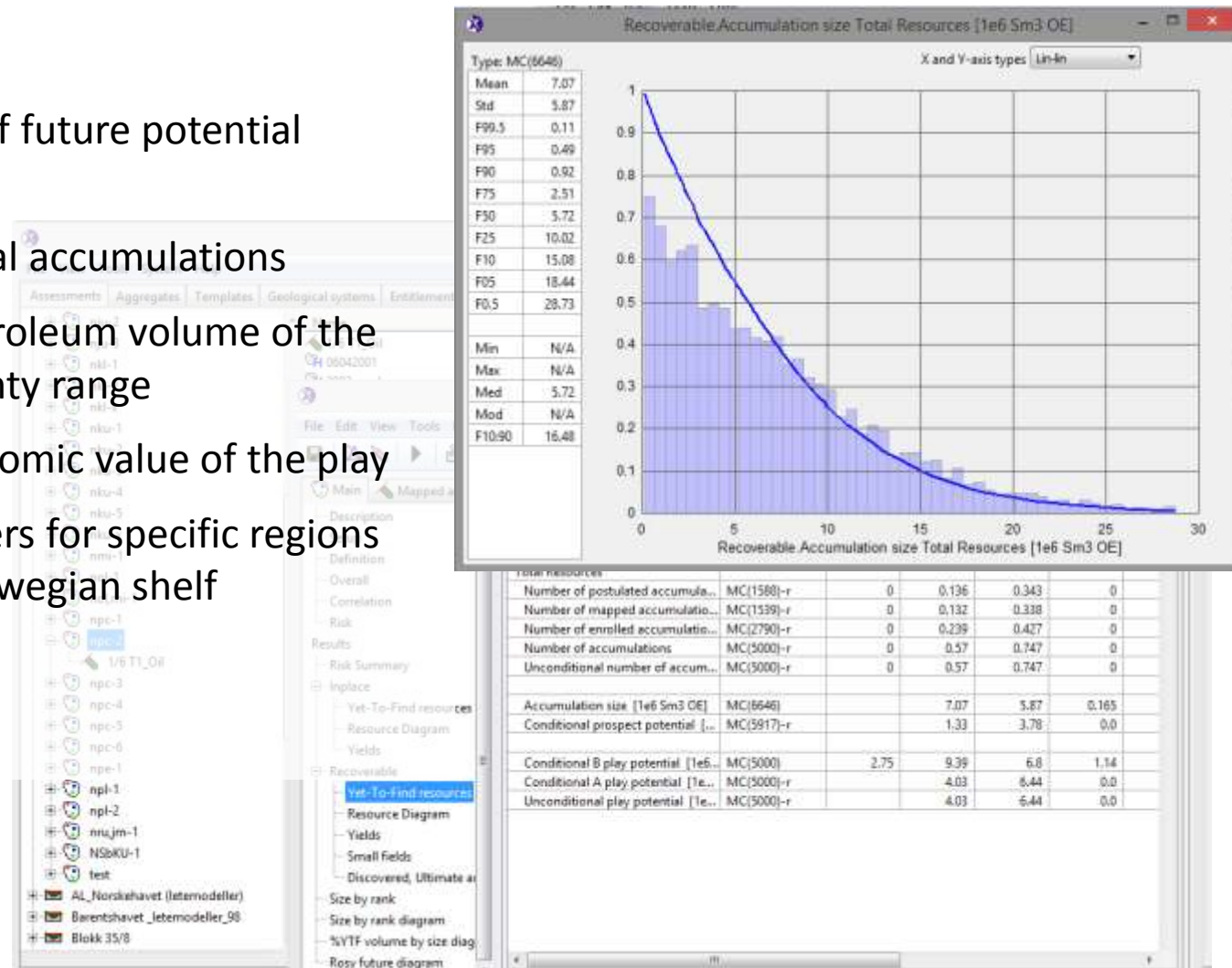
Play assessment procedure in NPD



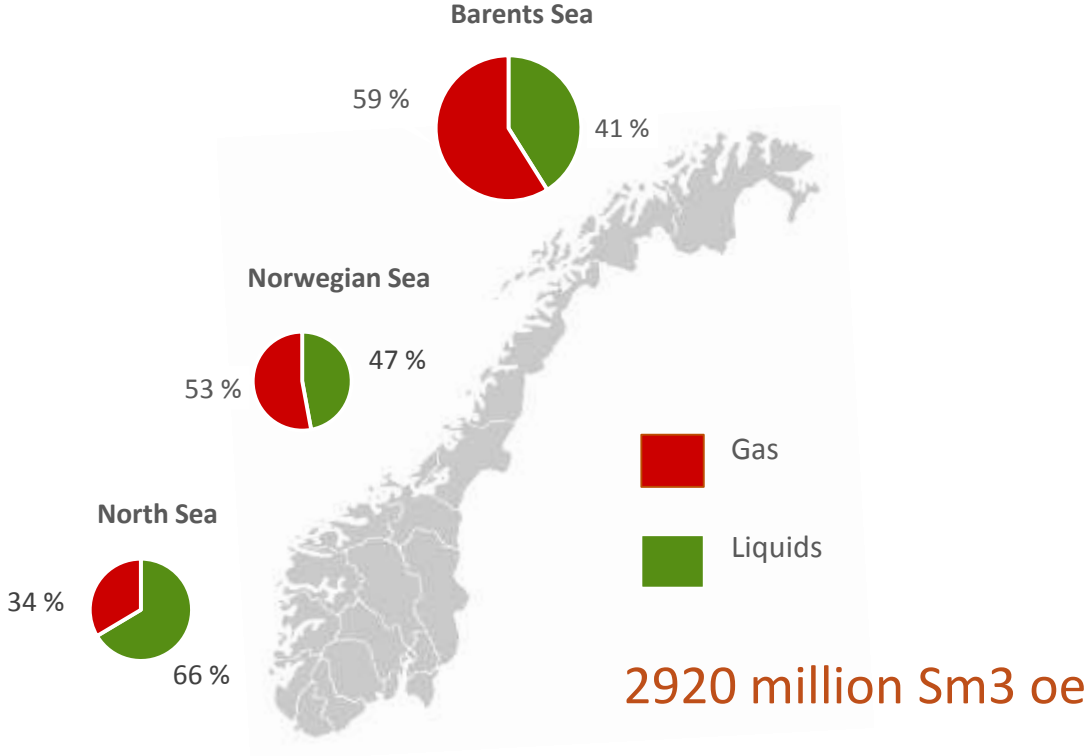
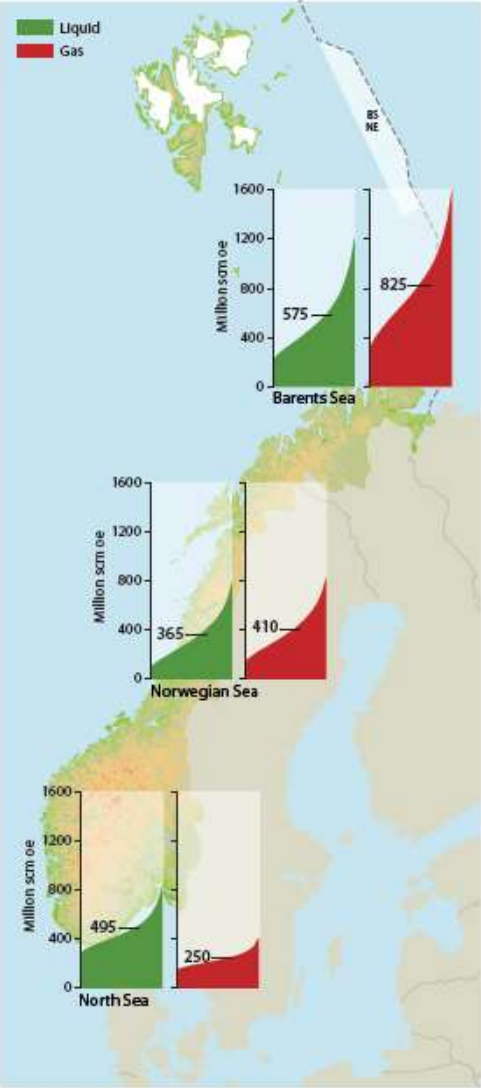
The play analysis is assessment of both the chance that the play exist - and the YTF potential of the play

Results:

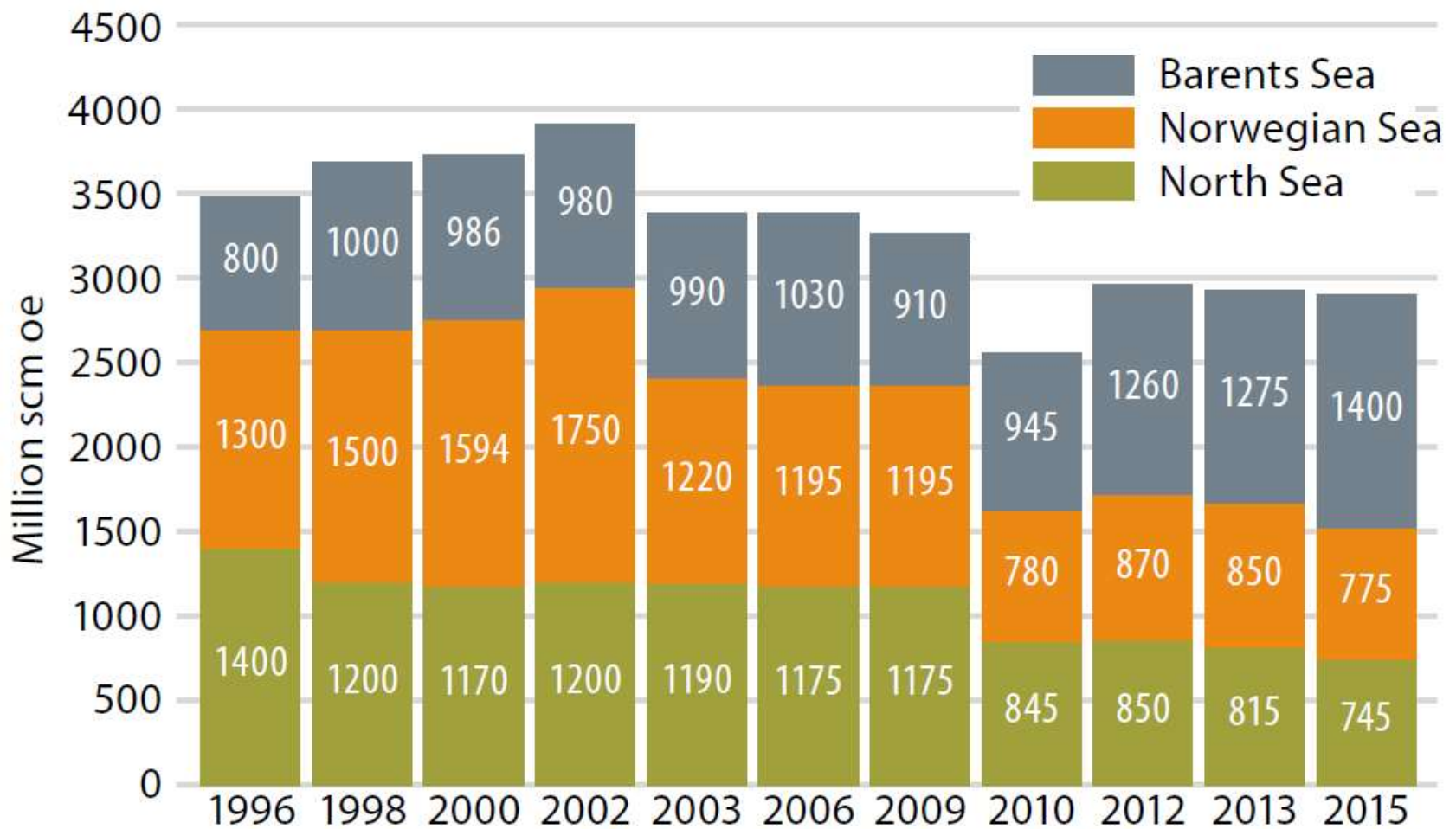
- Number and size of future potential accumulation
- HC type in potential accumulations
- Total potential petroleum volume of the play with uncertainty range
- The potential economic value of the play
- Aggregated numbers for specific regions and the entire Norwegian shelf



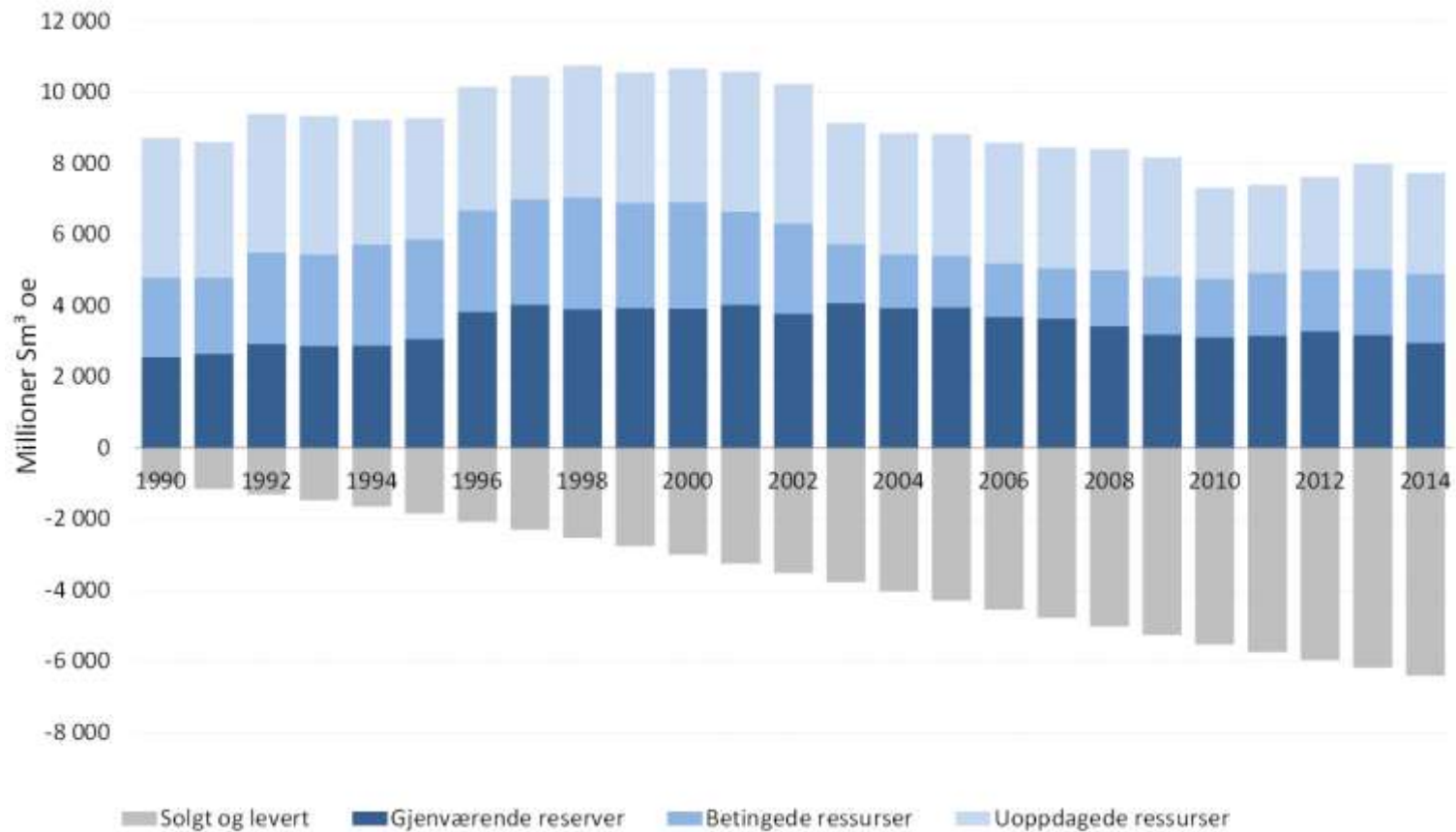
Undiscovered resources split by regions



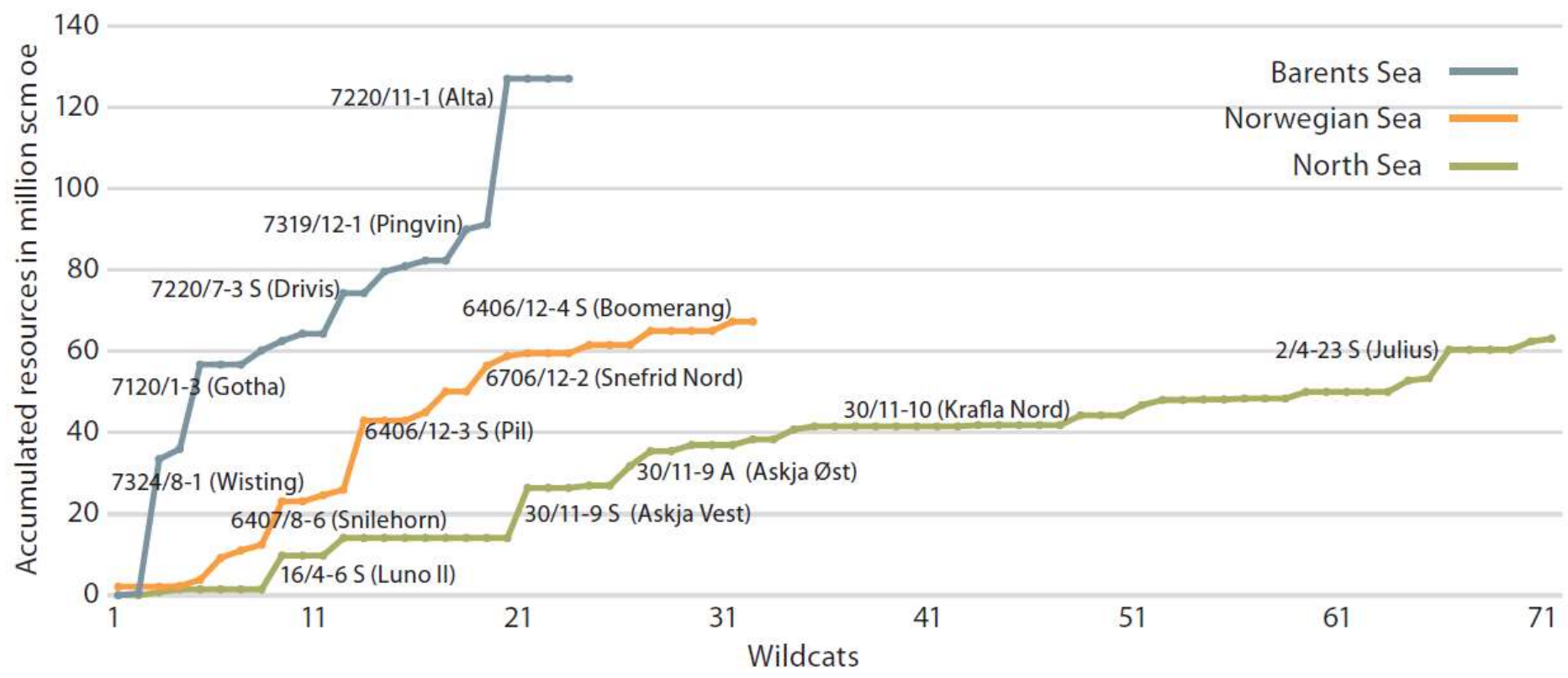
Total recoverable undiscovered resources over time for each part of the NCS



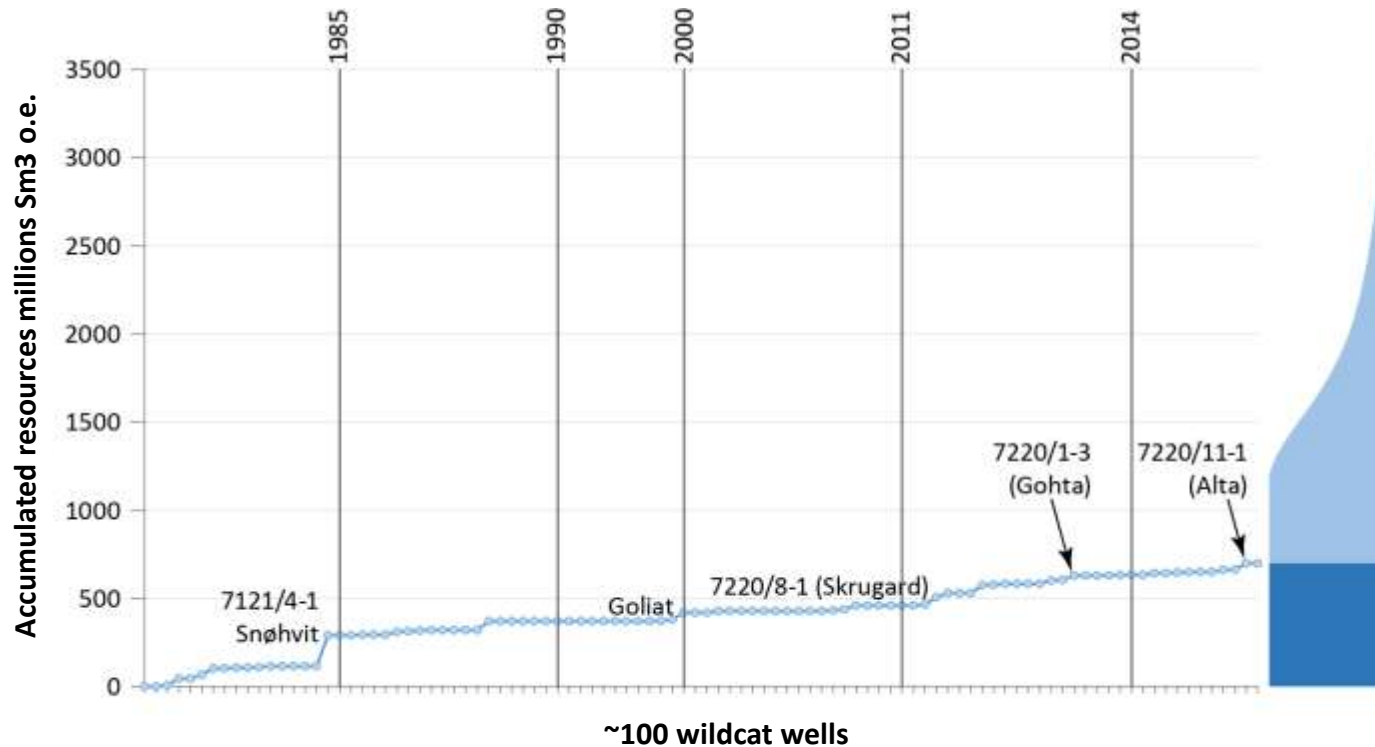
Remaining resources



Creaming curve for the NCS 2013-15



Creaming curve including undiscovered resources, Barents Sea



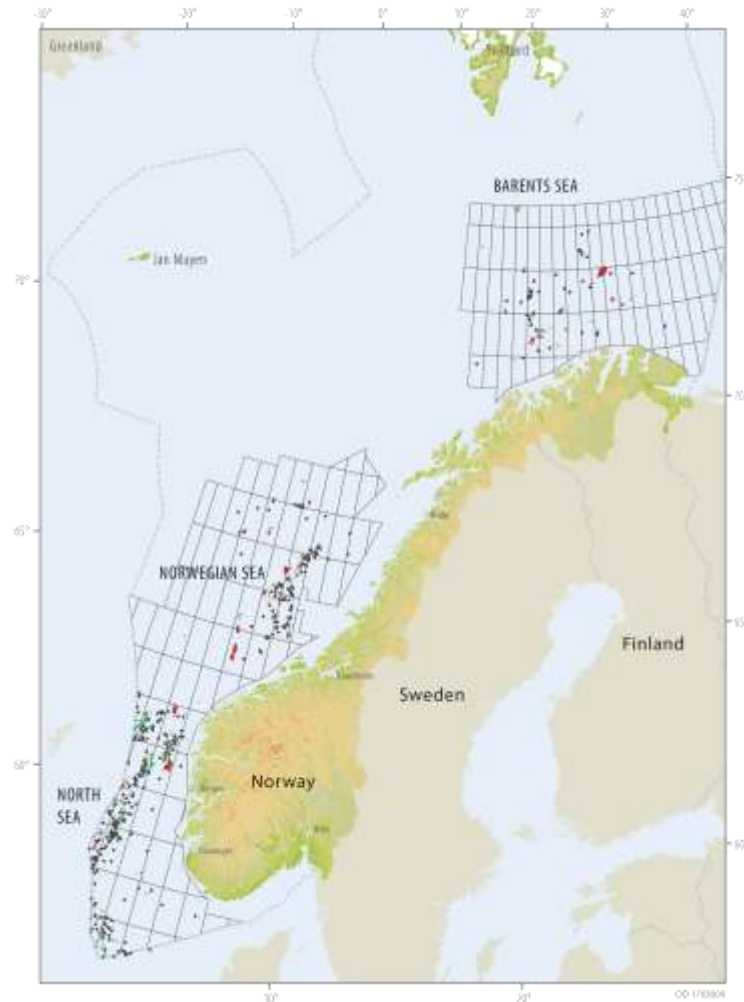
Creaming curve updated February 2015, undiscovered resources updated December 2013

OD 1501025

Exploration failures on the Norwegian continental shelf

- Wildcats (2007 - 2016)
- Focus: dry targets and reason for failure

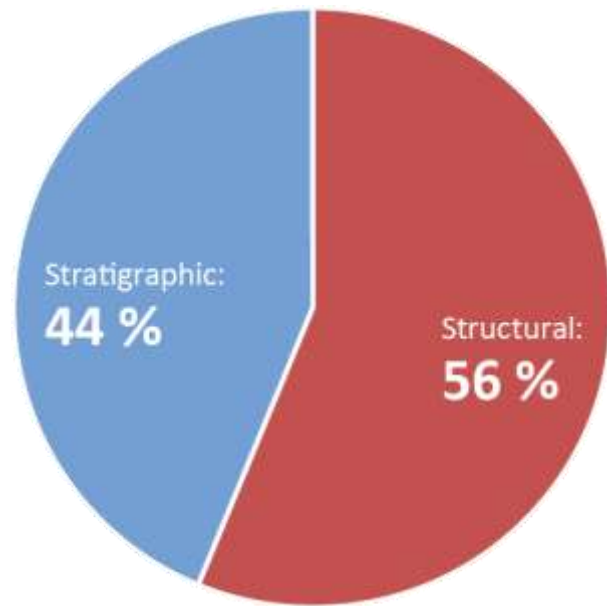
- **North Sea: ~ 200 targets**
- **Norwegian Sea: ~ 100 targets**
- **Barents Sea: ~ 70 targets**



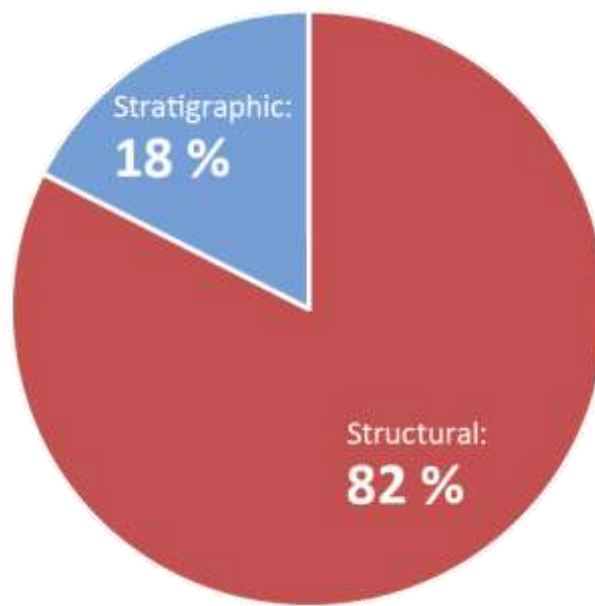
All targets – trap types



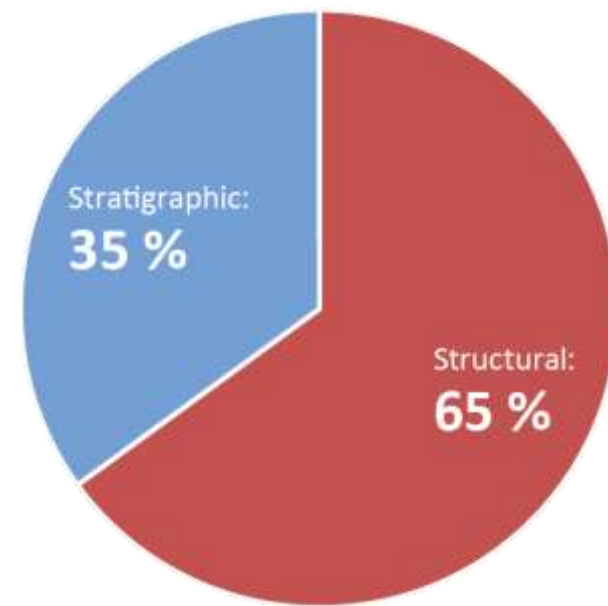
Barents Sea



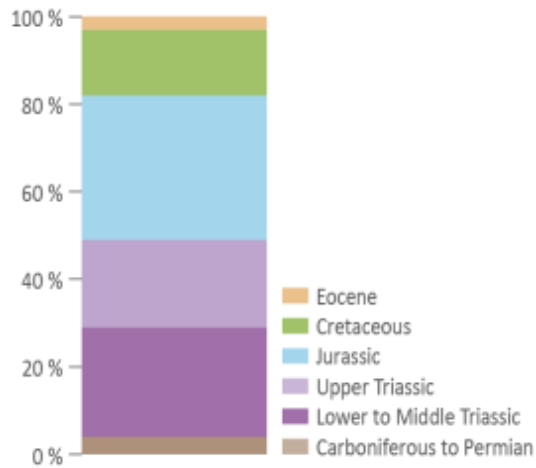
Norwegian Sea



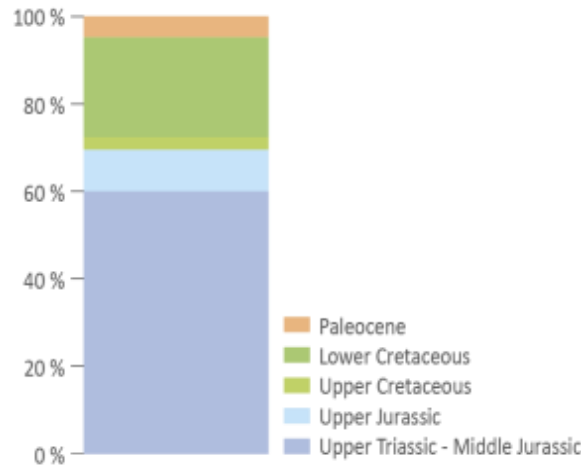
North Sea



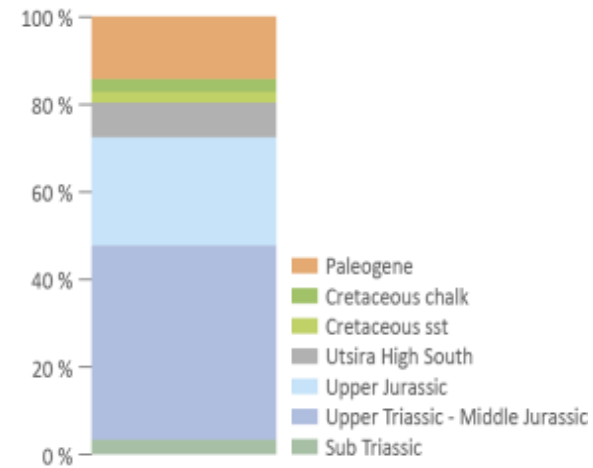
NCS All targets – stratigraphic level



Barents Sea

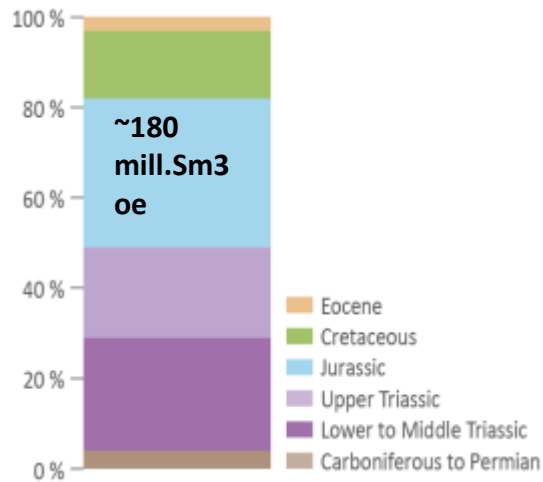


Norwegian Sea

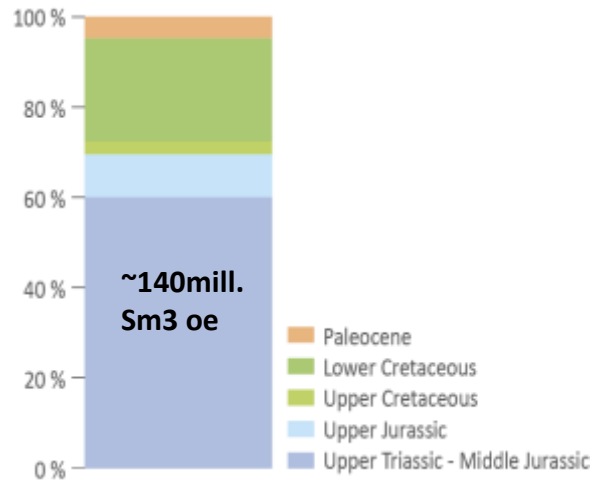


North Sea

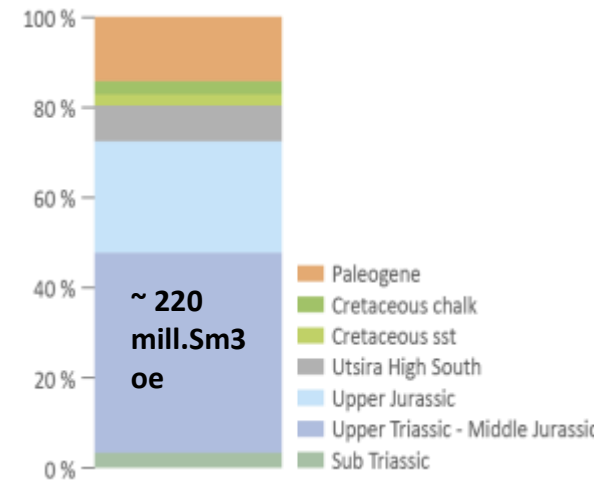
Discovered volumes in most tested targets



Barents Sea

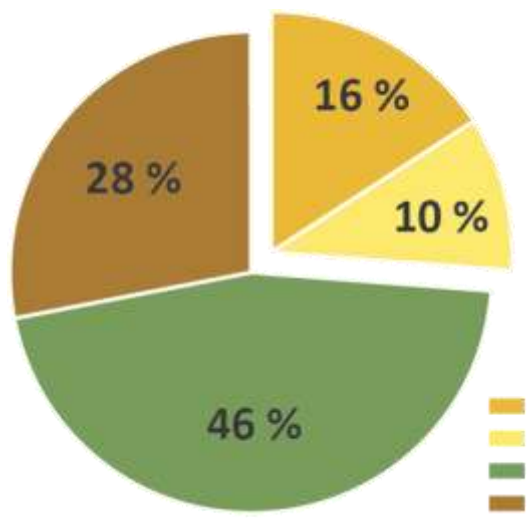


Norwegian Sea

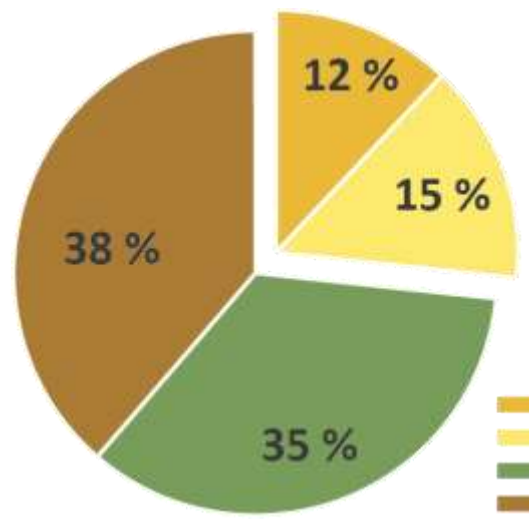


North Sea

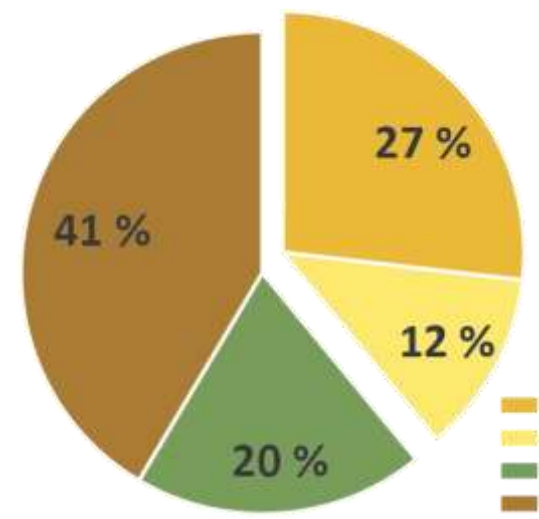
Main reasons for failure



North Sea



Norwegian Sea



Barents Sea

- Reservoir Presence
- Reservoir Quality
- Source/Charge
- Trap

Charge	Presence of source
	Maturity of source
	Migration of HC
Trap	Presence of closure
	Presence of top seal
	Presence of lateral seal
Reservoir	Presence of reservoir
	Quality of reservoir

In Summary:

-Still many opportunities for exploration on the NCS



- The Authorities work hard to give the industry access to these opportunities
- Maintaining a long-term perspective
- important to learn from earlier mistakes and successes

**Thank you for
your attention!**

