

Rotliegend Play Evaluation

Ruby and Cygnus area

February 2021

ebn

Energising the transition



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The project

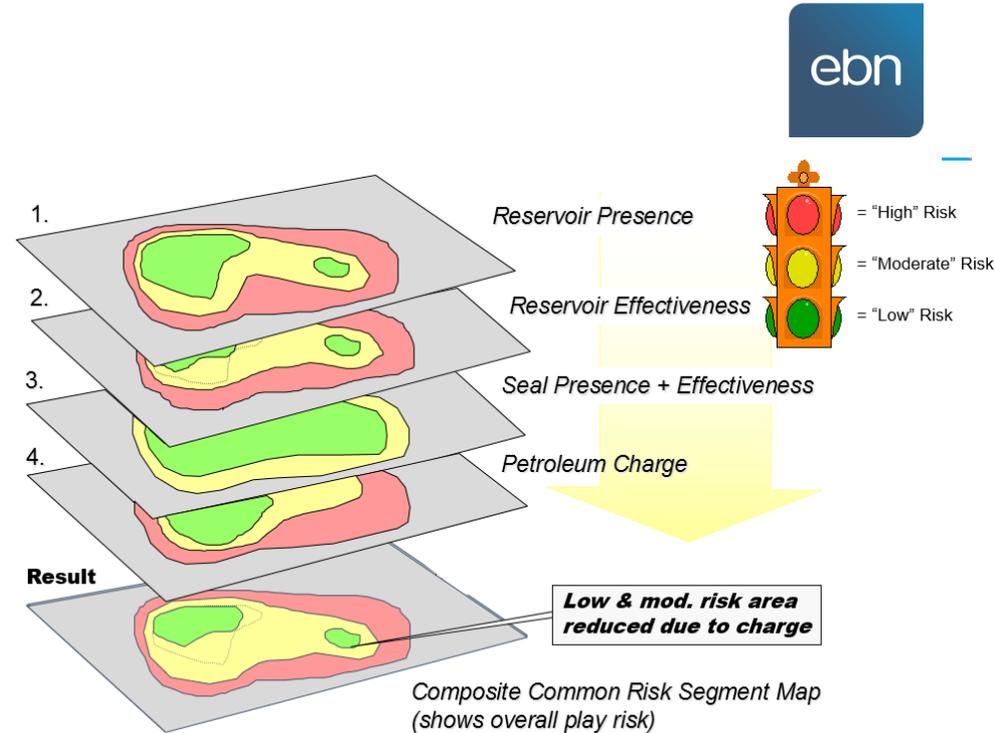
- Play analysis of the Dutch offshore Rotliegend
- Creating and analyzing regional risk maps
- Use of public data only

What are the areas with the highest potential of fin hydrocarbons?

Made in Player, PBE Extension of Arc-GIS

- Combine and overview different spatial layer
- What are the regional geological risks?
 - Reservoir
 - Seal
 - Charge

Cartoon from: <http://www.geologyin.com/2014/12/hydrocarbon-traps.html>



after Fraser 2012

Overview of this presentation

ebn

General geological introduction

Play mapping approach

Analysis of the Cygnus area

Analysis of the Ruby area

Conclusions and what is next?

Appendix: Methodology

Rotliegend group

- Prolific gas reservoir
- Main contributor to our Dutch gas
- Well known
- First Dutch discovery in 1950's

Legend

 Rotliegend Fields

• Wellhead location of Rotliegend penetration

 Rotliegend eroded at younger unconformity

Upper Slochteren Reservoir Facies:

 Dunes

 Fluvial Plain

 Upper Playa

 Lower Playa

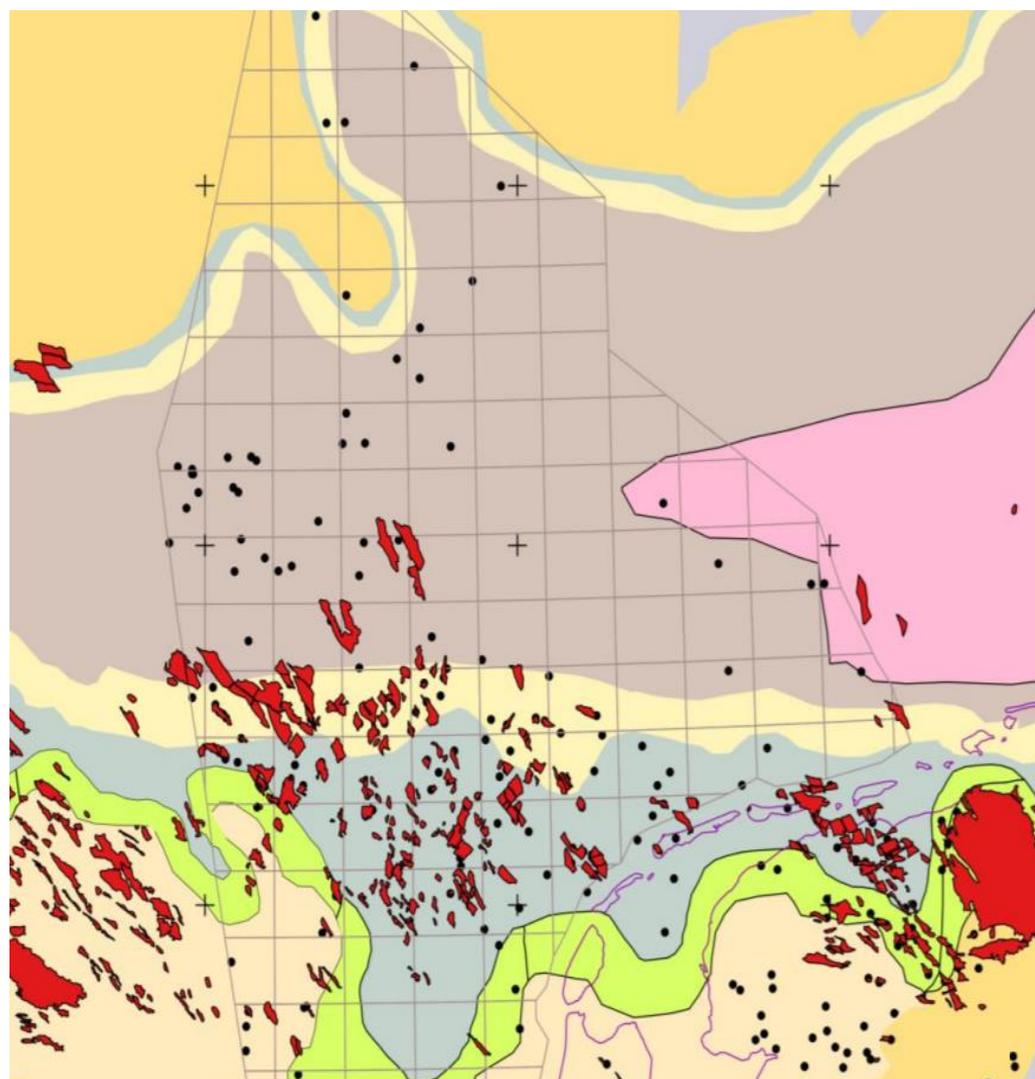
 Playa margin

 Playa lake

 Sabkha

 Massif/High

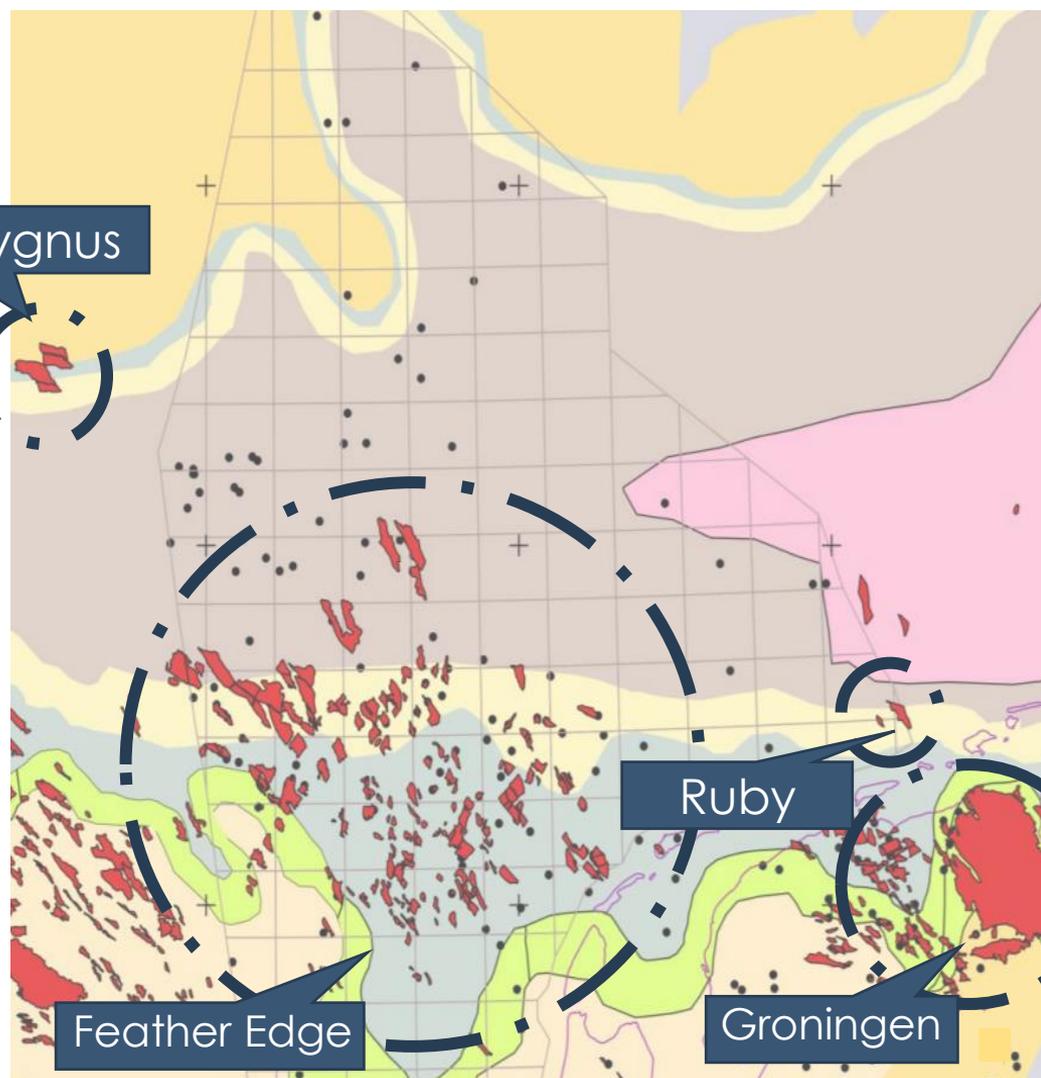
 Salina



Rotliegend play

- 1959 – Groningen
- 1968 – Offshore Rotliegend, Feather edge
- 2016 – Cygnus field
- Rediscovery (80's)
- One of the largest field in the last 30 years
- 2017 – Ruby field
- ONE-Dyas
- New sub-play concept

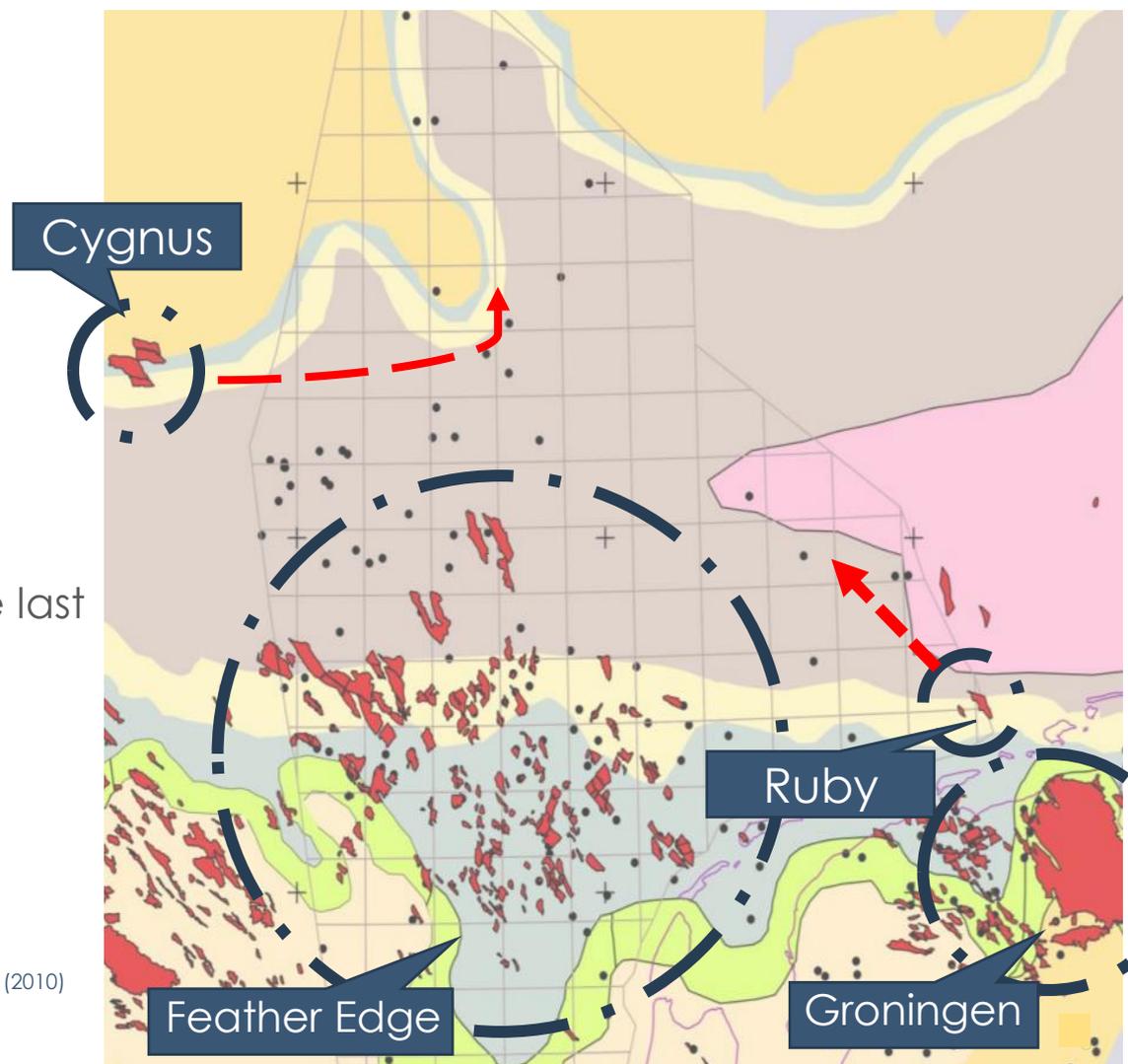
Cygnus



From Dutch Exploration Day 2018. Modified after Doornenbal et al. (2010)

Rotliegend play

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From Dutch Exploration Day 2018. Modified after Doornenbal et al. (2010)

Rotliegend cross-section

Vertical context

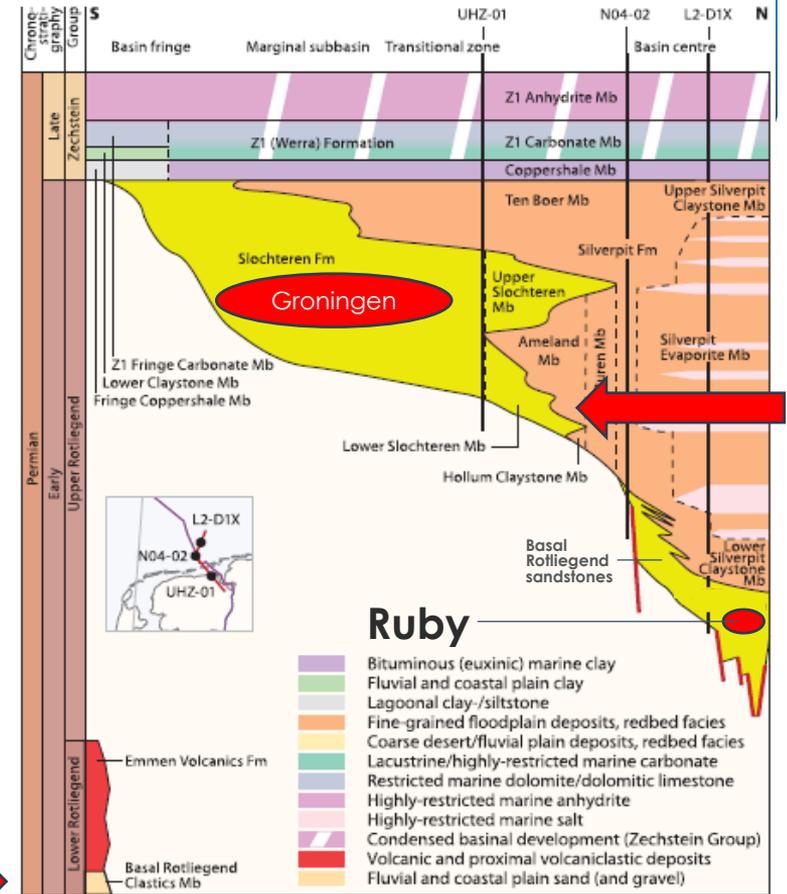
Feather edge fields located in Slochteren formation

Ruby

- Havel/Ruby/Findorff/Basal Rotliegend sandstones
- Older Lower Slochteren in MG blocks

Cygnus

- Field: Lower Slochteren member
- Area includes
 - Lower Slochteren member
 - Basal Rotliegend clastics



Modified from Doornenbal et al., 2020

Play based Exploration method



Advantage of PBE

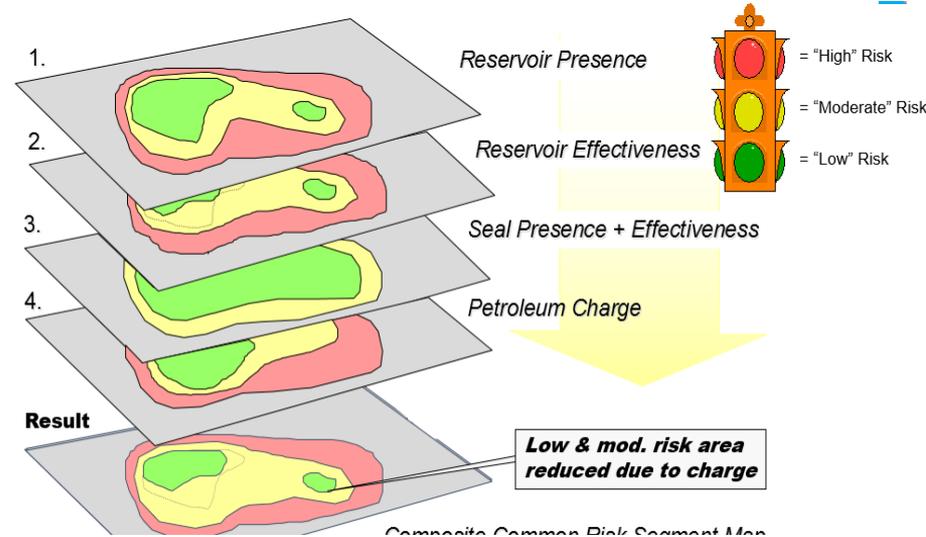
- Prospect portfolio in context



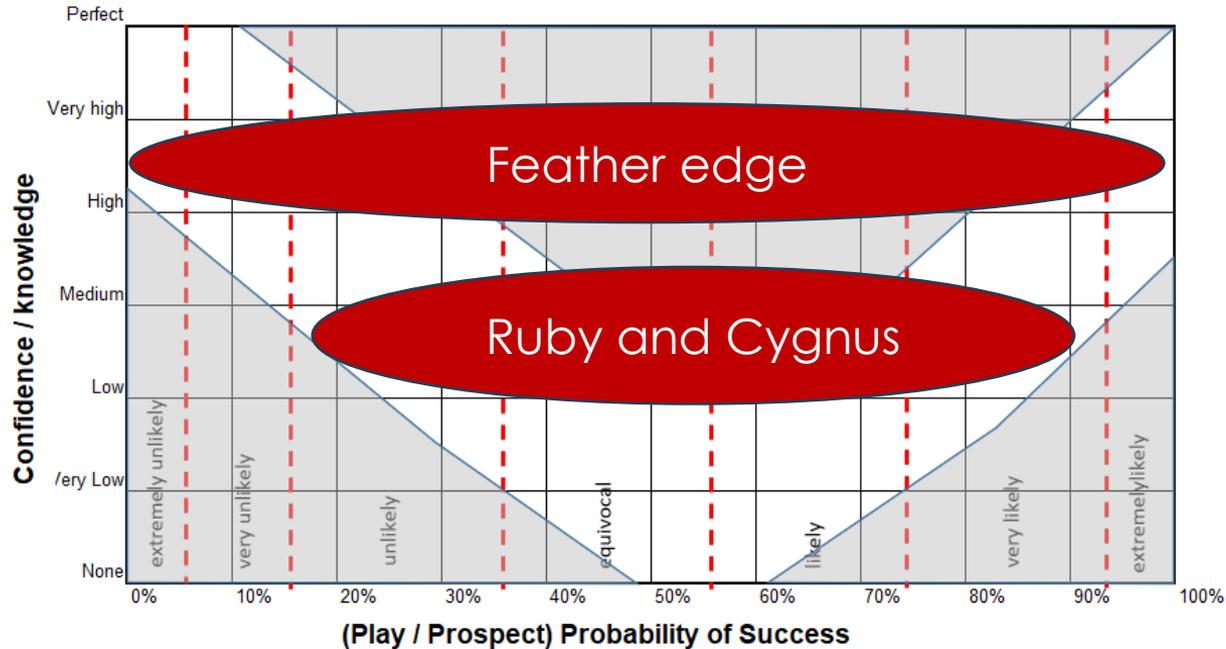
Common Risk Segment Maps



- Maps for specific play elements
- Each polygon has its own geology and data quality – therefore its own risk
- Boundaries determined by geology or data quality
- Wells determine if our elements is proven



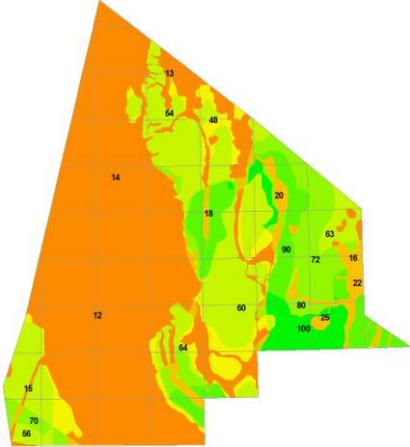
Determining the probability of success



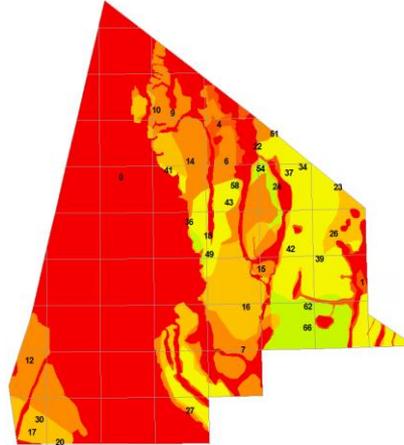
Bullshorn plot from EBN

Split Risking Approach (see appendix for explanation)

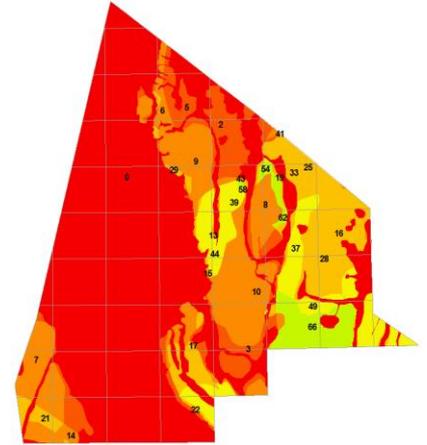
Play Chance



Repeatability Chance



Total POS



$$\text{Play Chance} \times \text{Repeatability Chance} = \text{Total Chance}$$

(shared)

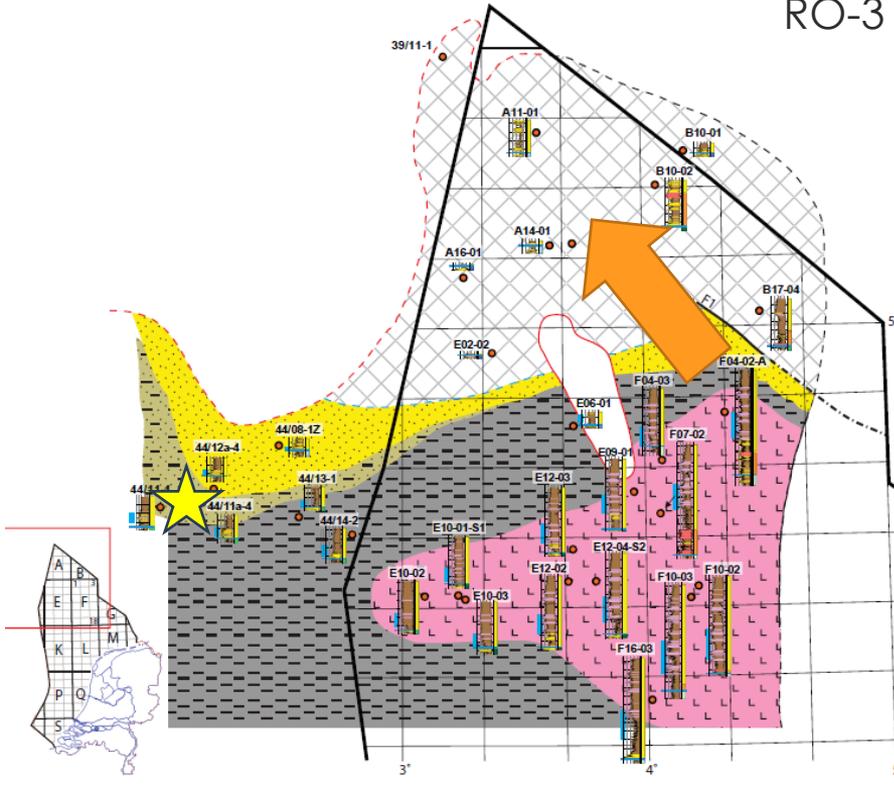
(non-shared)

(POS)

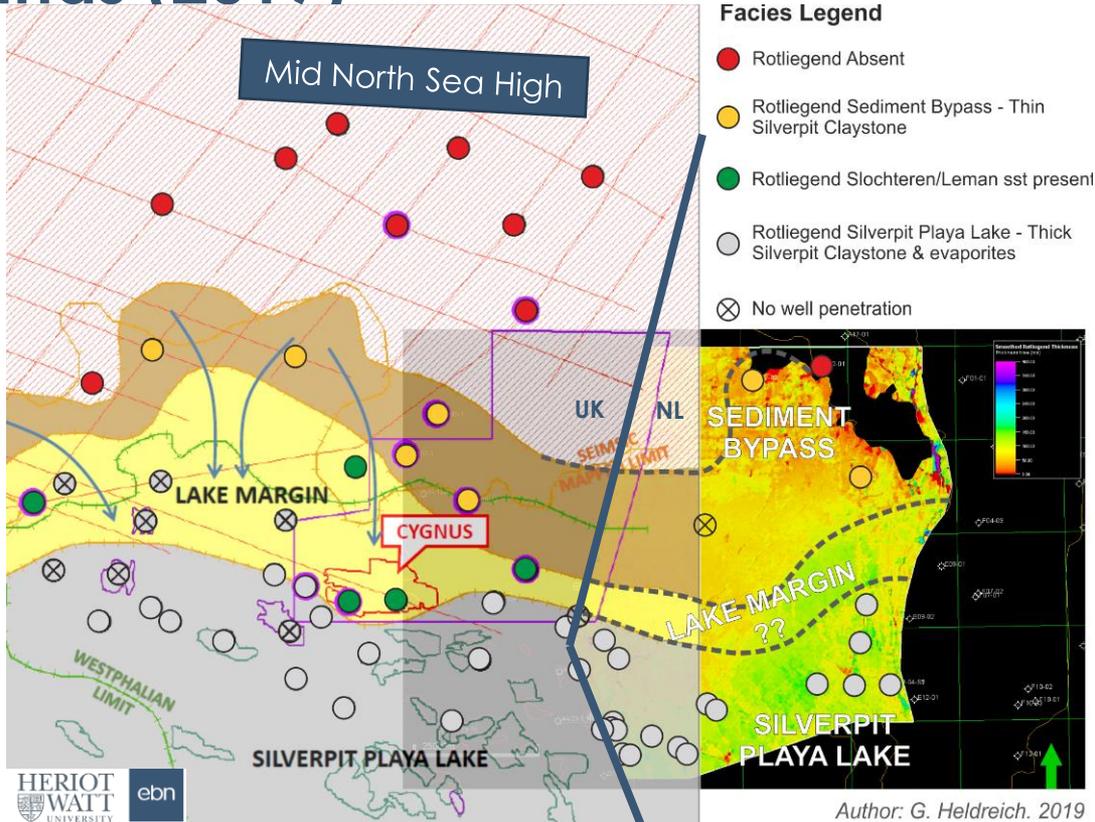
Extension of the Cygnus reservoir to the Netherlands (2015)

RO-3

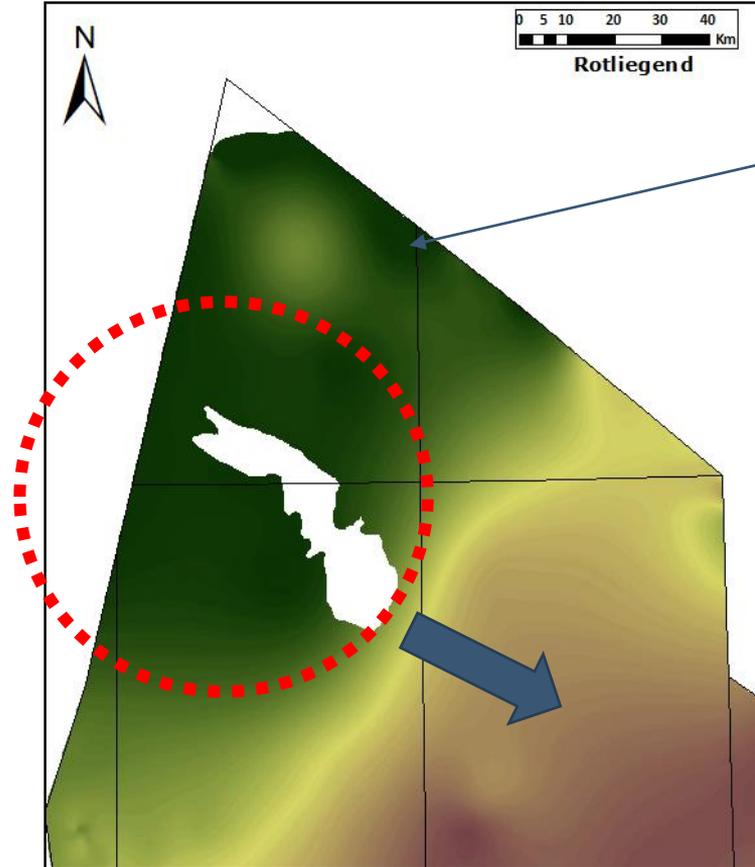
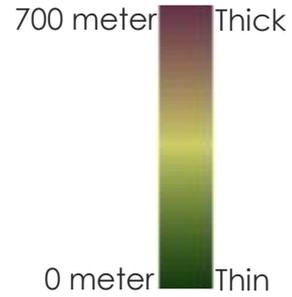
RO-4



Extension of the Cygnus reservoir to the Netherlands (2019)



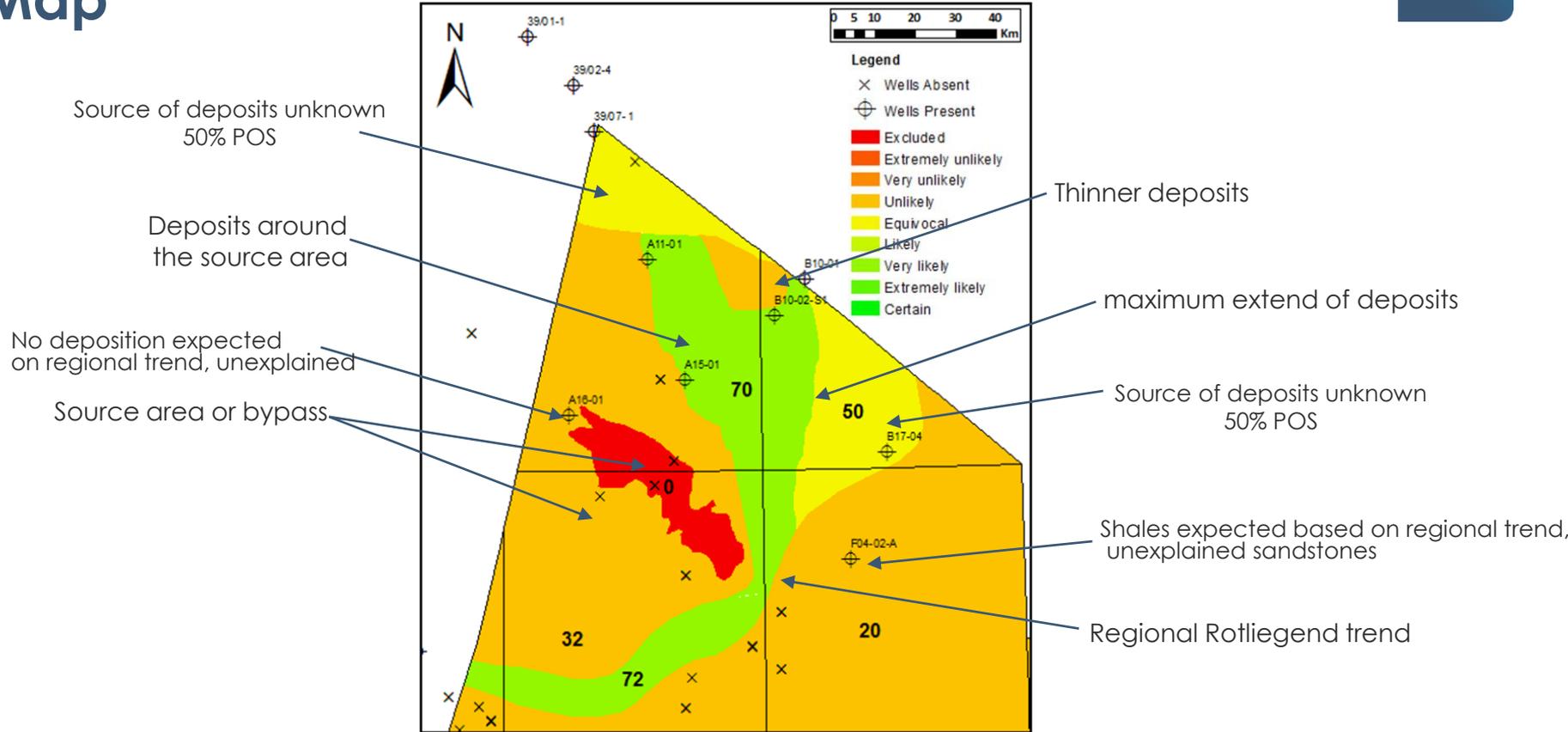
DGM-5 Rotliegend group thickness



Thin deposits



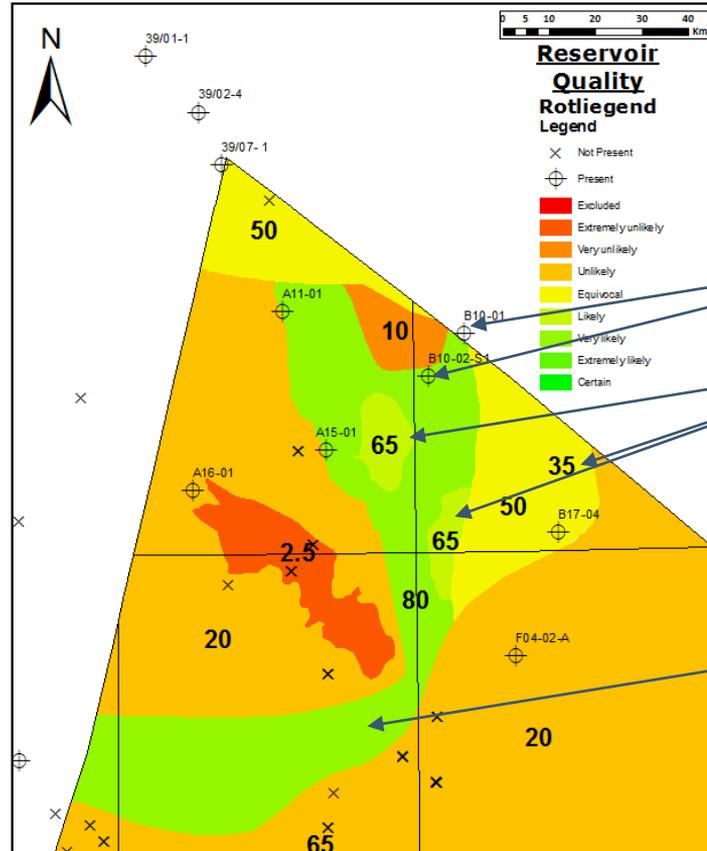
Reservoir Presence Common Risk Segment (CRS) Map



Reservoir Quality Common Risk Segment (CRS) Map



- Expected facies
 - Shales reduce permeability
 - Badly sorted reservoir reduces porosity
- Depth
 - Compaction reduces permeability
 - Continued burial causes illite formation

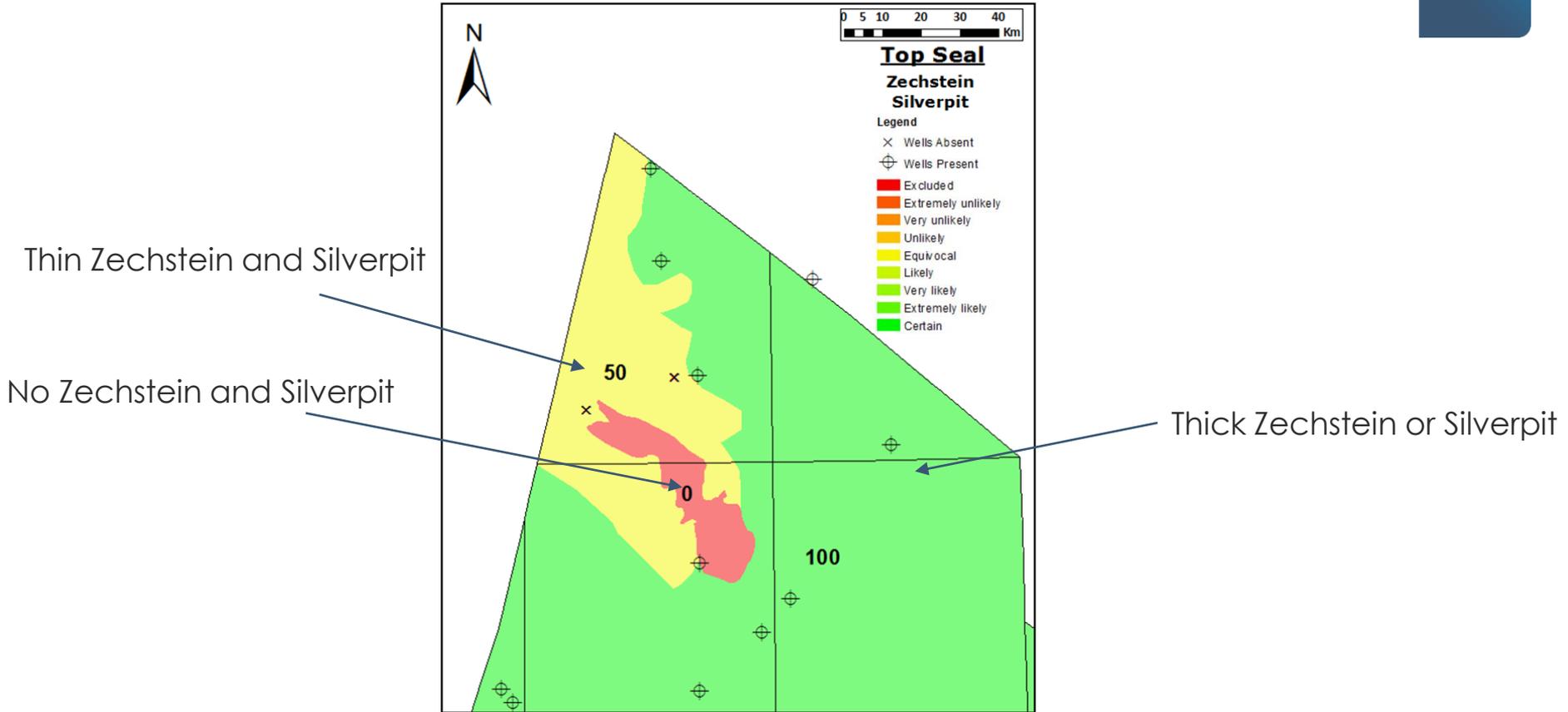


Good porosities

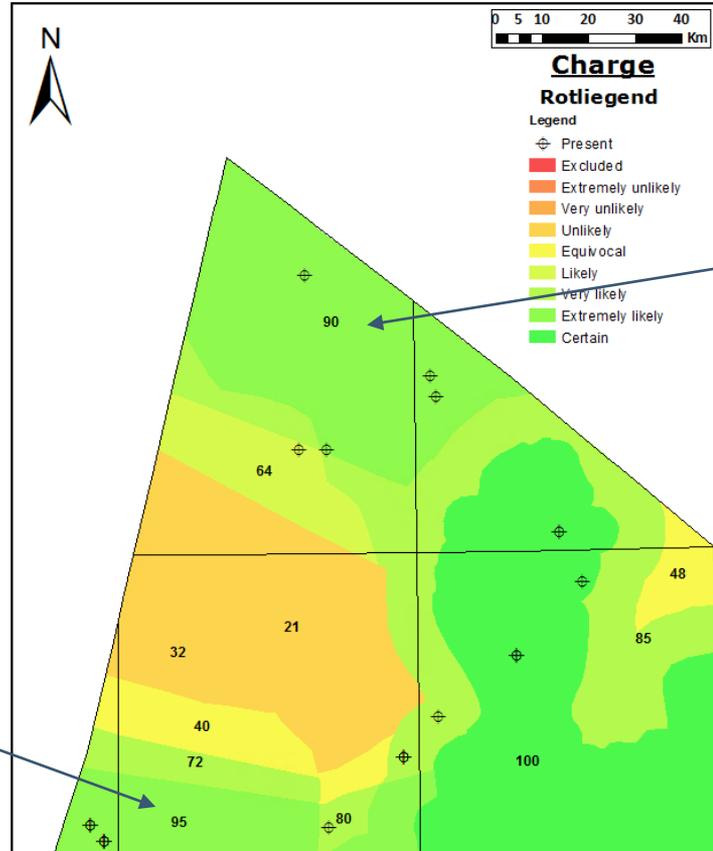
Deeper burial

Alluvial fluvial fan deposits like the Cygnus field

Top seal Common Risk Segment (CRS) Map



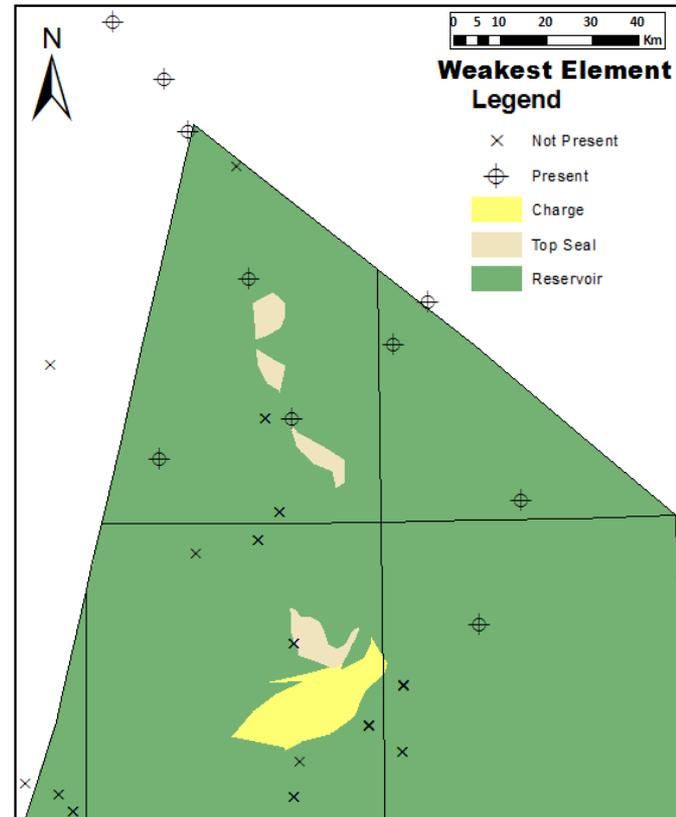
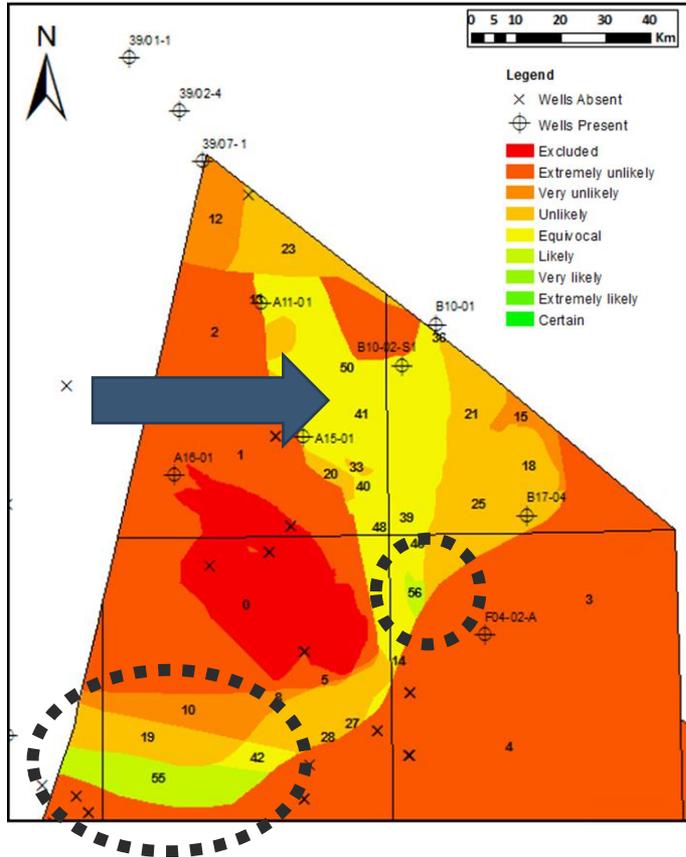
Charge Common Risk Segment (CRS) Map



Scremerston Formation

Epen formation

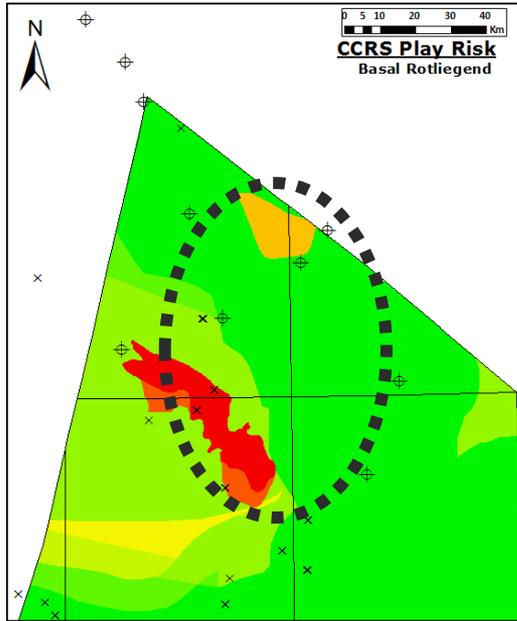
Combined Common Risk Segment Map



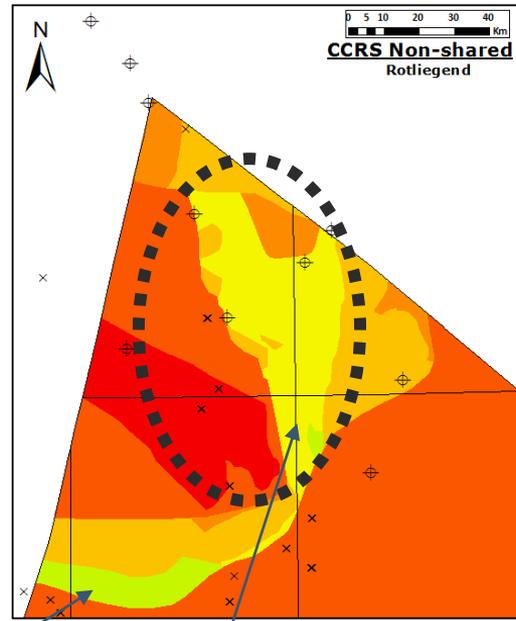
Variations of POS determined by data quality



Proven Play Elements

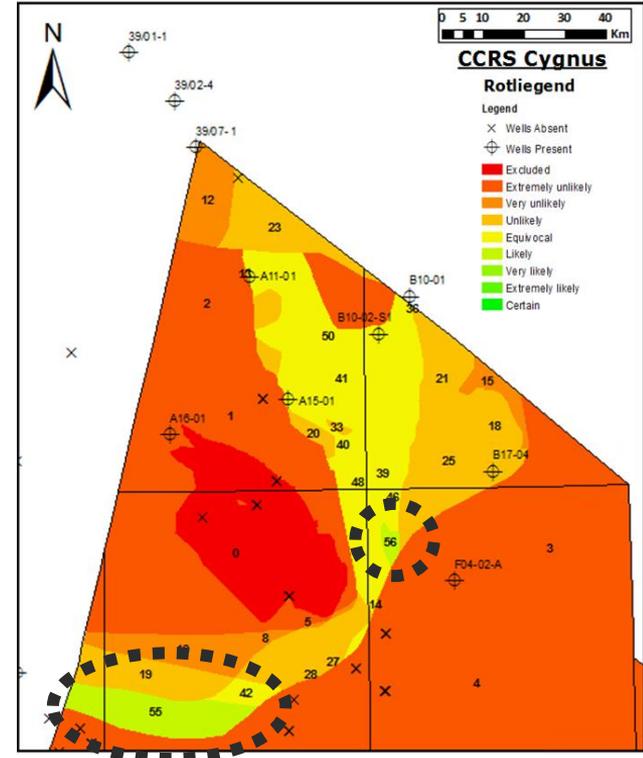


Data quality, expected geology



DEF-survey

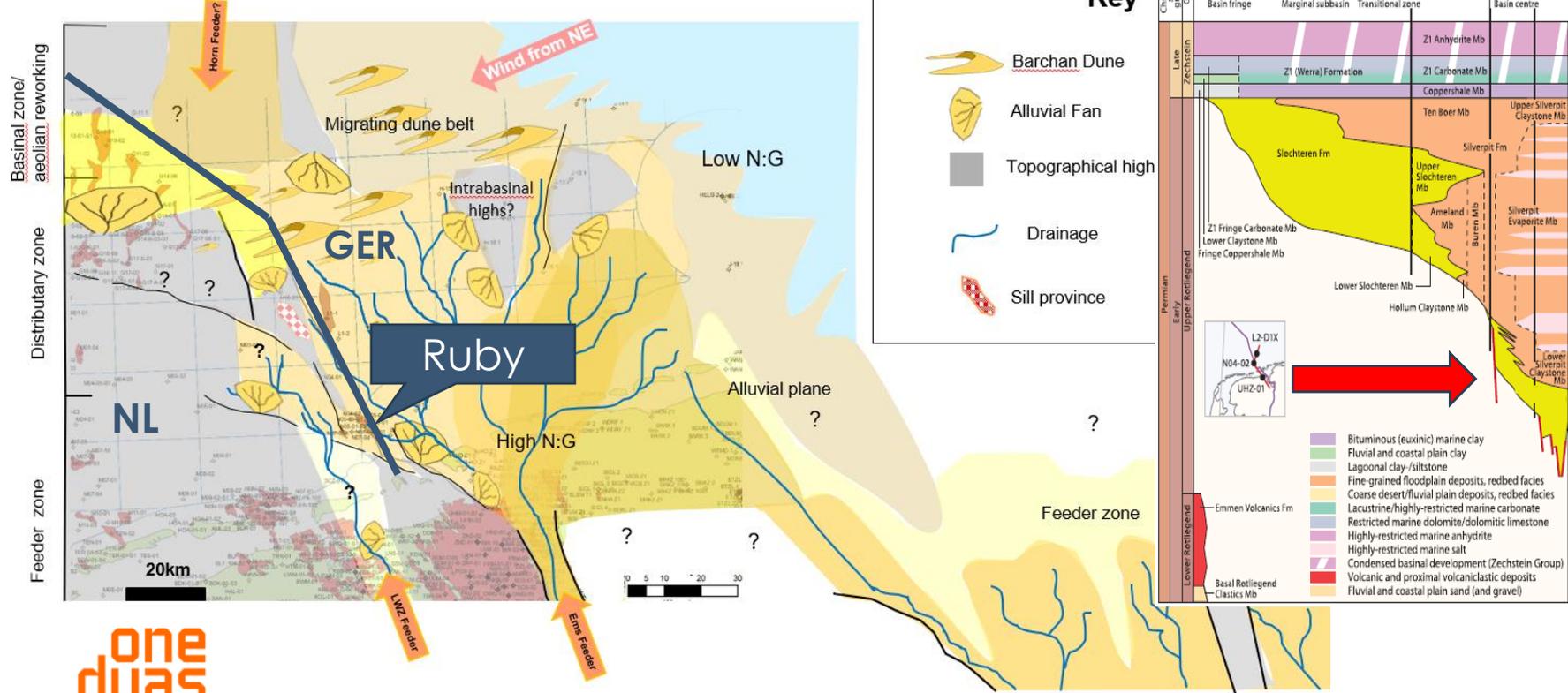
Same geology
Lower data quality



Basal Rotliegend sandstones



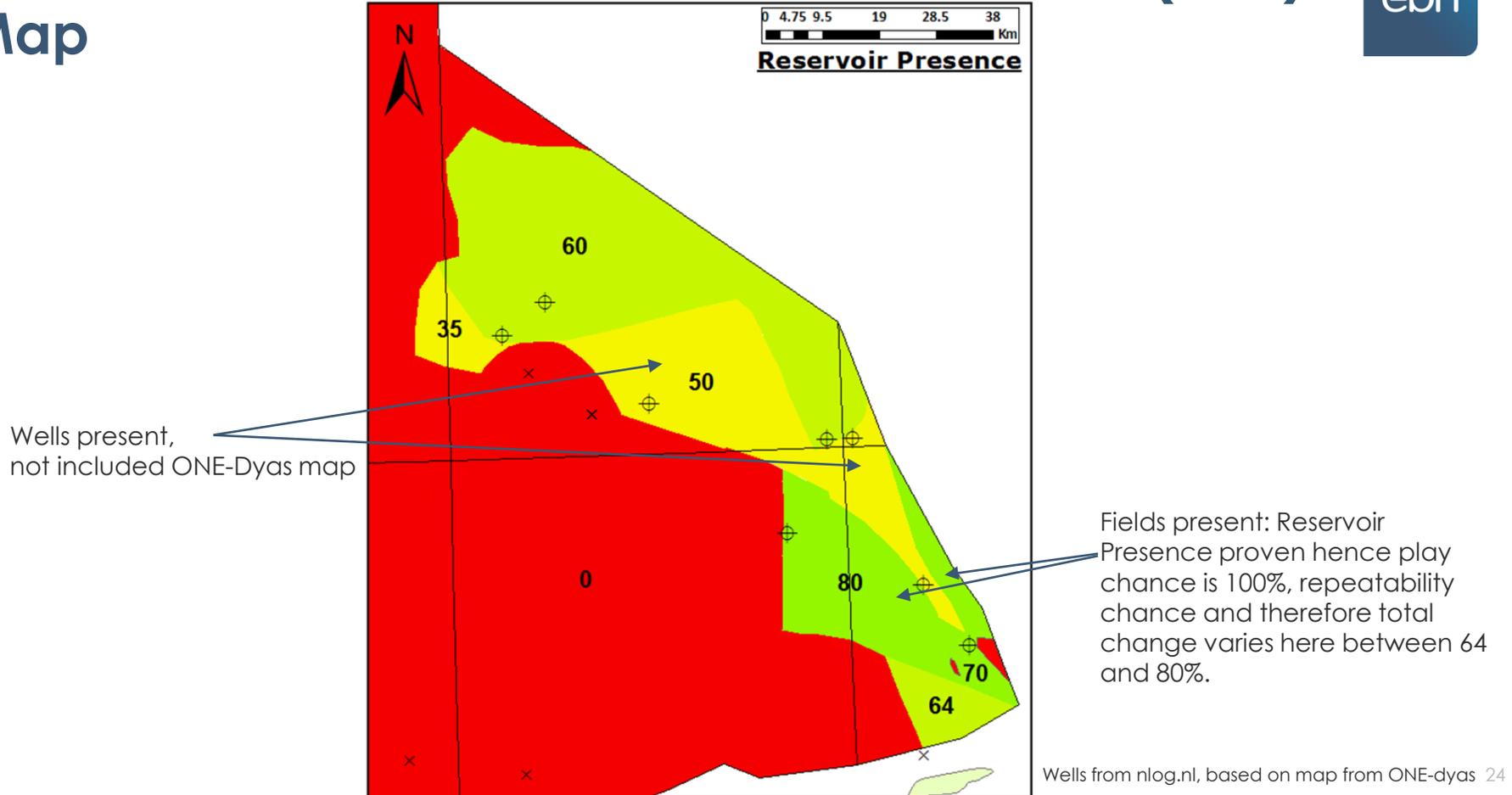
Courtesy of One Dyas



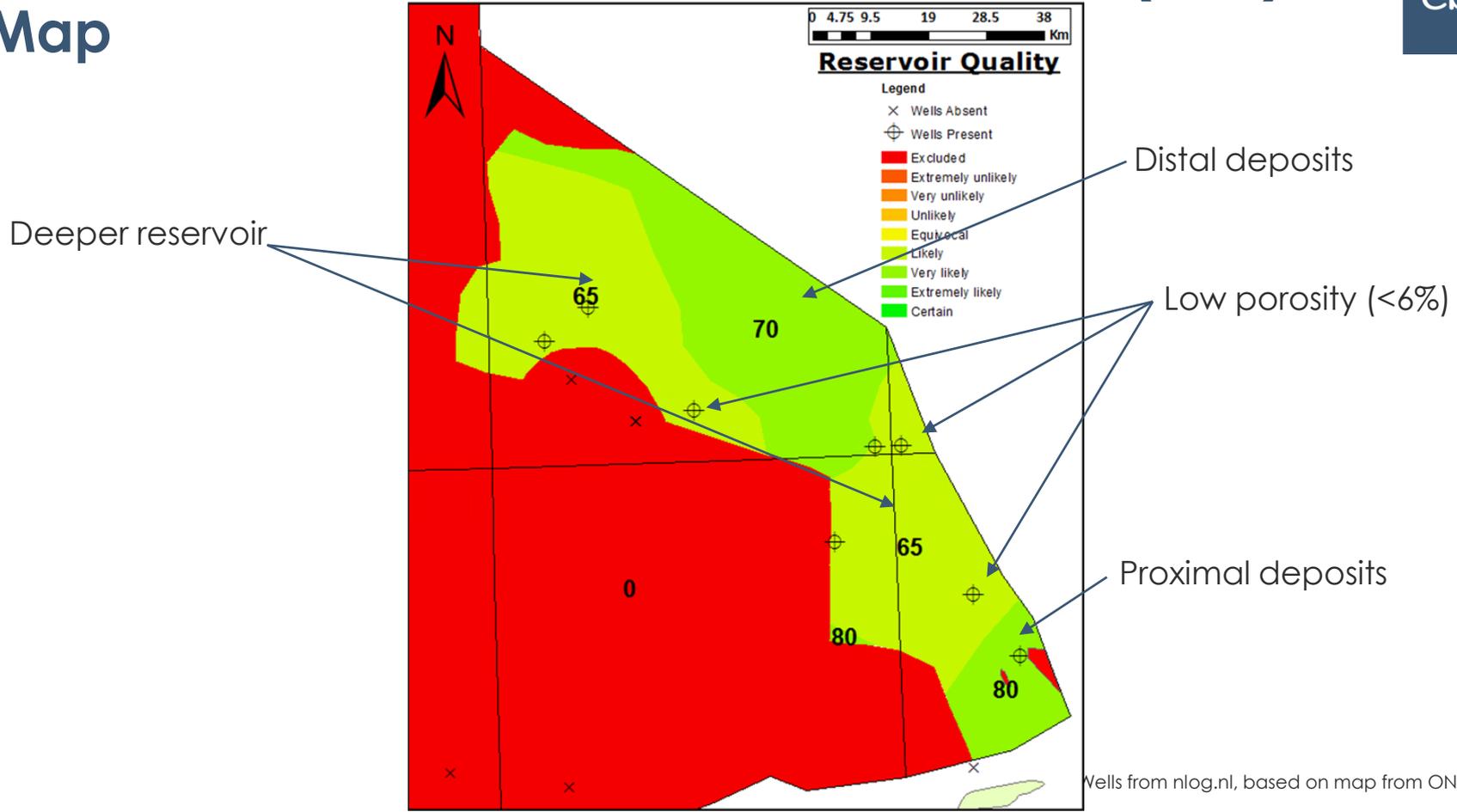
From: Exploration Day 2018

Lower Saxony Rift System

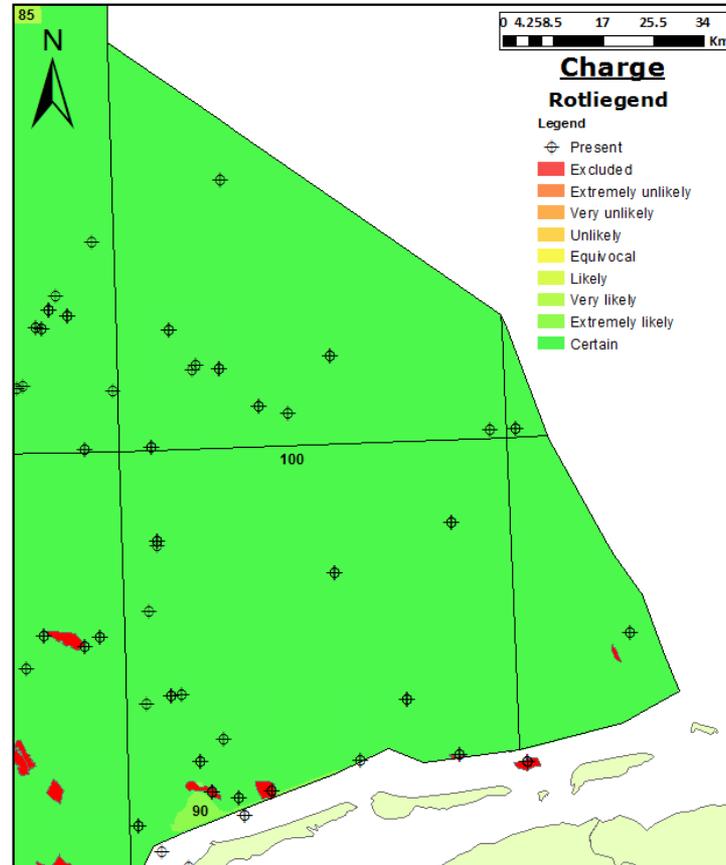
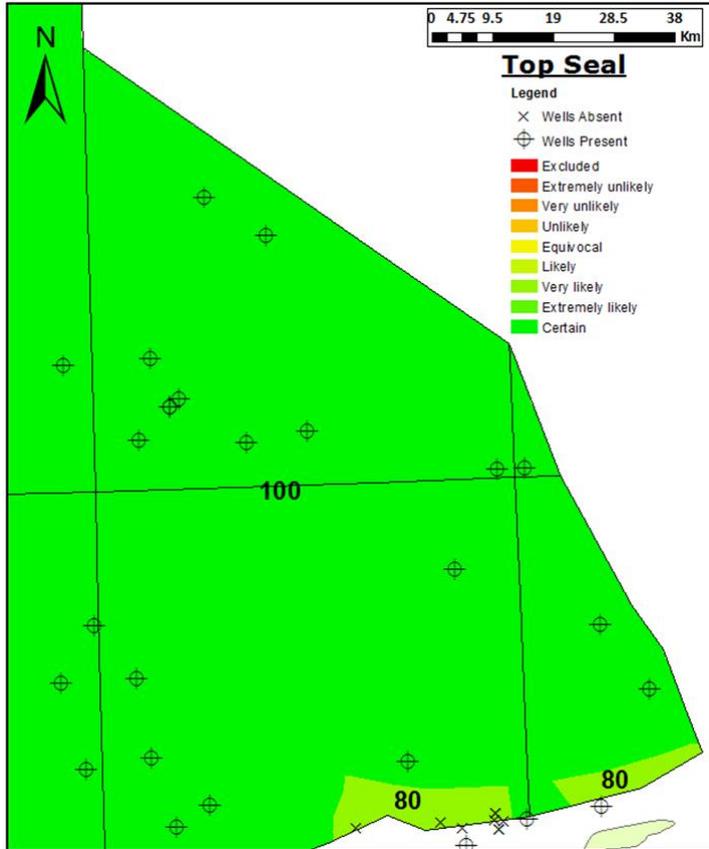
Reservoir Presence Common Risk Segment (CRS) Map



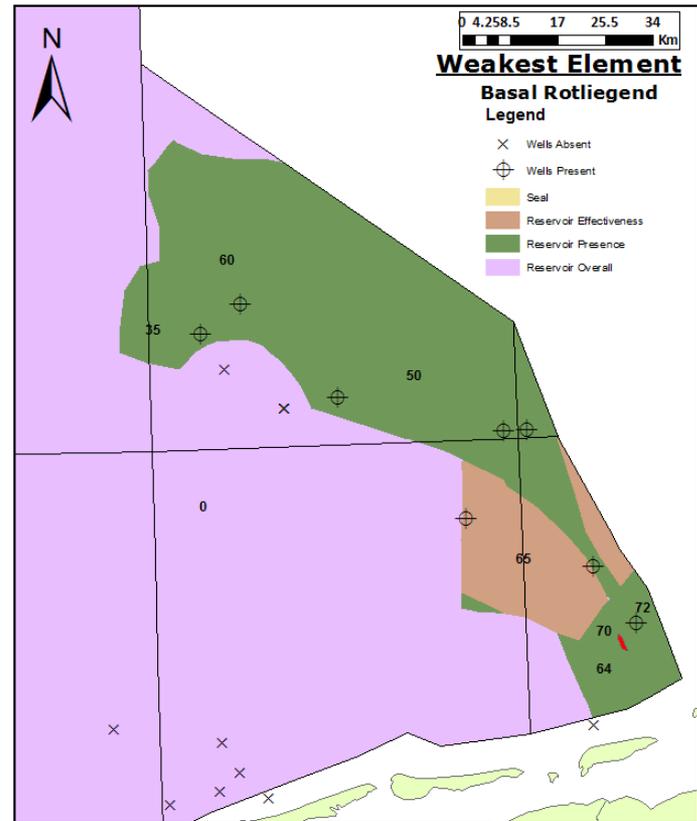
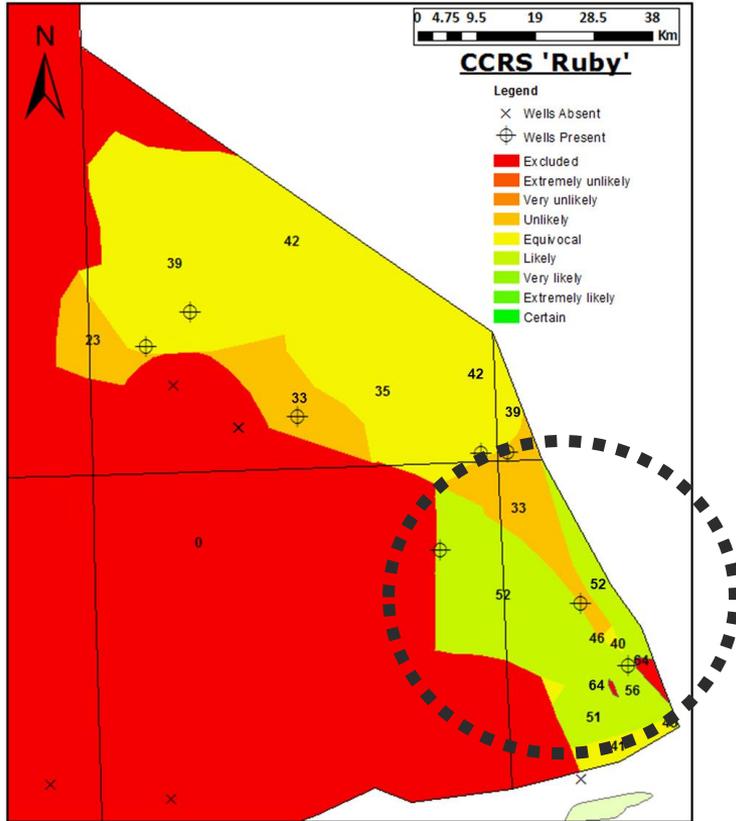
Reservoir Quality Common Risk Segment (CRS) Map



Common Risk Segment (CRS) Map



Combined Common Risk Segment Map

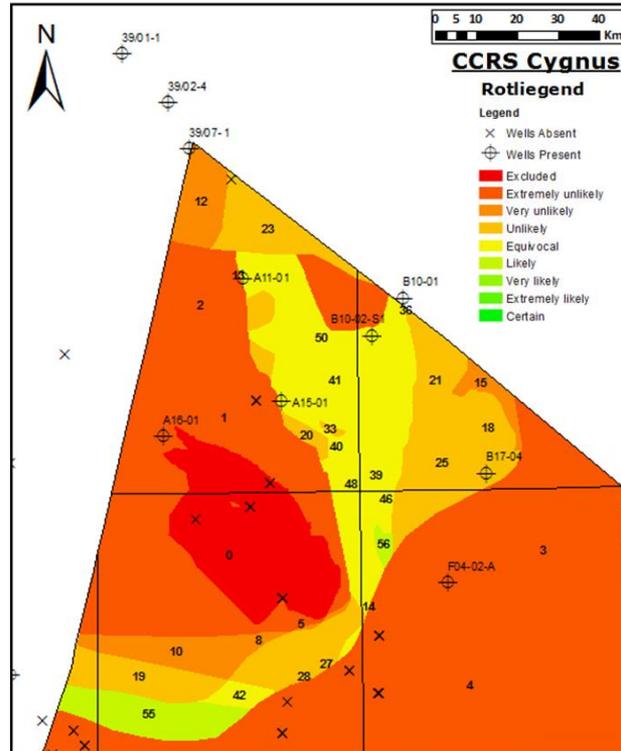


Potential of Cygnus and Ruby



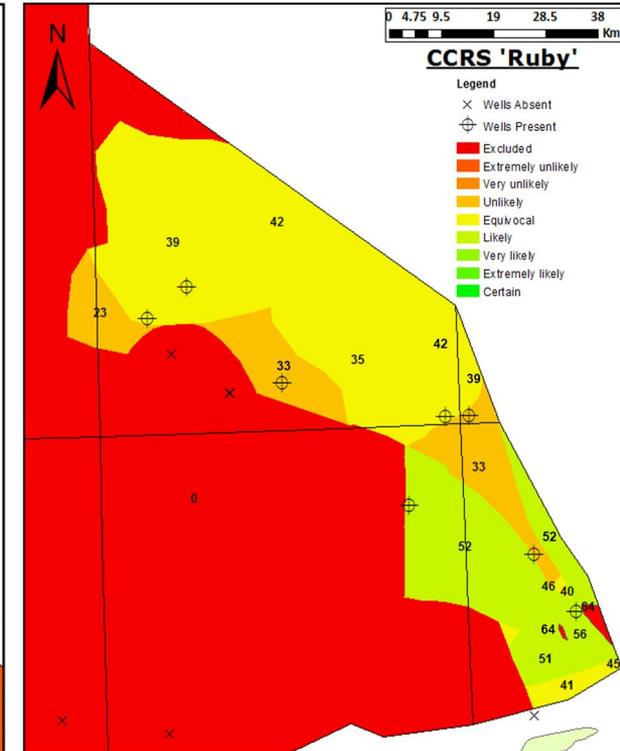
Cygnus

- Opportunity for Dutch Cygnus?
- Main risk is reservoir presence
- Highest probability of success in the south



Ruby

- Opportunity of more 'Rubies'?
- Main risk is reservoir
- No top seal or charge risk
- Highest probability of success in the south



Thank you for your attention!

Additional thanks to:

Audrey Roustiau, Kees van Ojik from EBN
and Fred Beekman from UU

Exploration team

ONE-Dyas

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The EBN logo consists of a dark blue square with rounded corners. Inside the square, the lowercase letters 'ebn' are written in a white, sans-serif font. The 'e' and 'b' are connected, and the 'n' is separate.

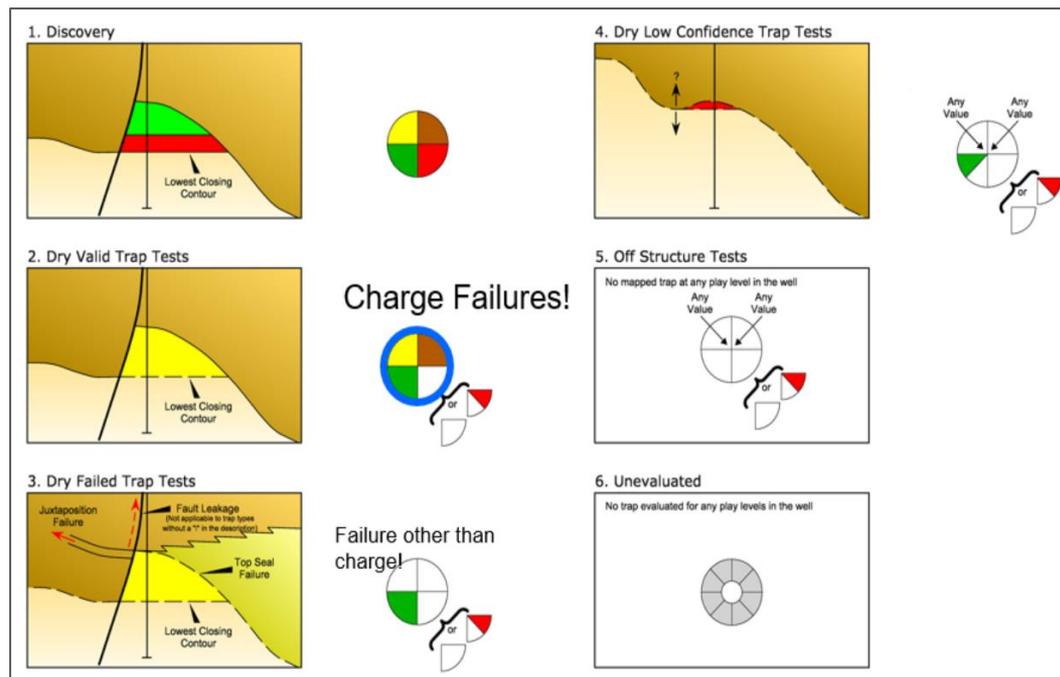
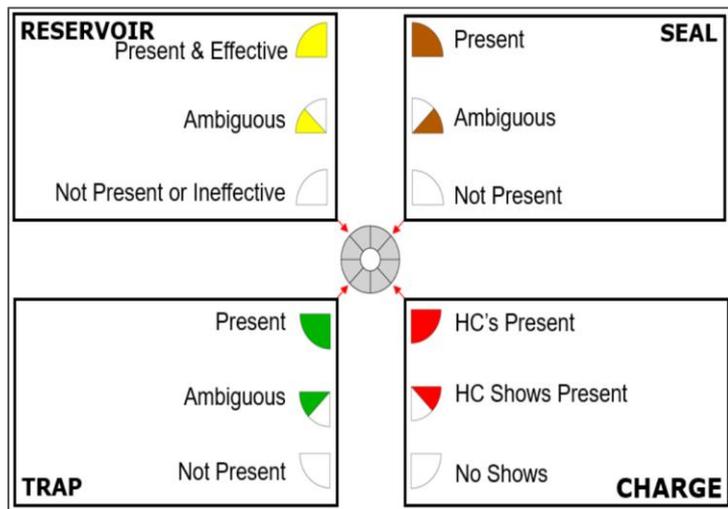
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Appendix: Methodology

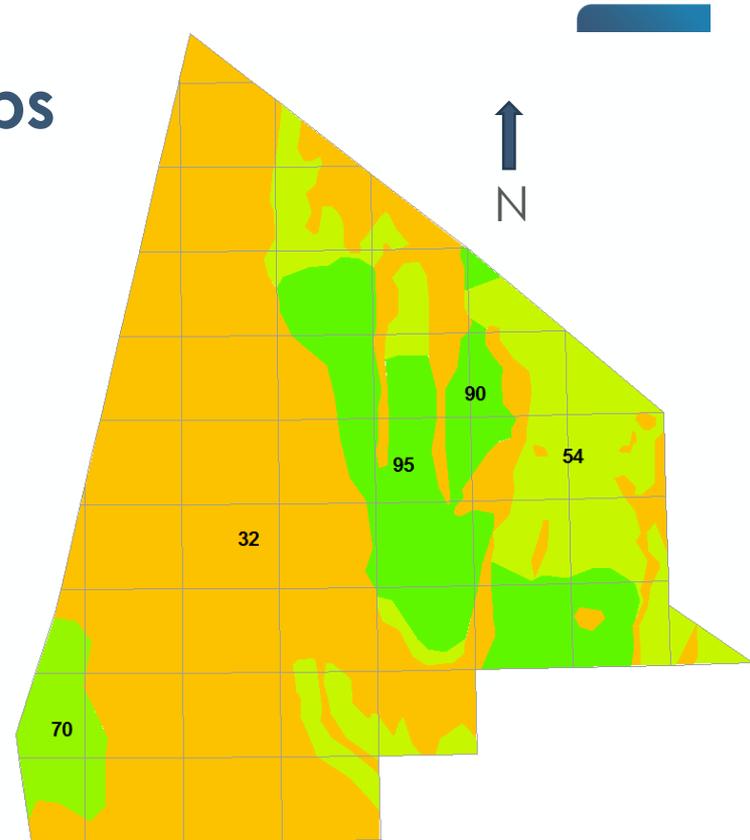
Post Drill Well Analysis

(This scheme is the Intellectual Property of GIS-pax and cannot be copied without permission)



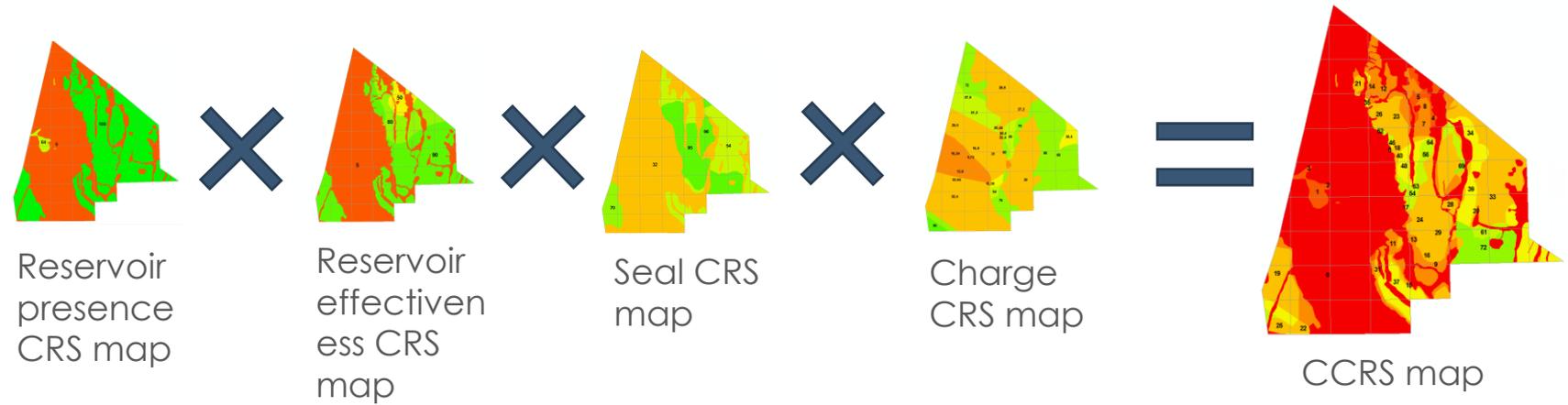
Common Risk Segment (CRS) maps

- Risk maps for specific play elements
- CRS = a confined area with uniform geological character and risk
- Boundaries are geological and/or data dependent



CRS map example

Aggregated Composite CRS map (CCRS)



Overall CCRS map is estimate of average prospect POS in play segment

Split risk stacking

Play/Shared Chance

- What is the probability that the play element is present somewhere in the play segment? If element is drilled and present in a well then the chance = 100%.

Repeatability/unshared Chance

- If the element is proven in the play segment then what is the future success rate/future repeatability of continuing to find that element? E.g if you drill 100 wells in the play segment how many do you think will find the element? 100% = uniform sheet element.

The repeatability risk is a.o. data quality dependent (e.g. 2d vs 3d seismic coverage)

Total Chance

- The product of the two should be the same estimate as a prospect POSg at play segment level.

Repeatability Chance (non-shared risk)

If there would be success in the polygon, what would be the repeatability

- Data quality
- Geology

Reservoir Presence repeatability

