

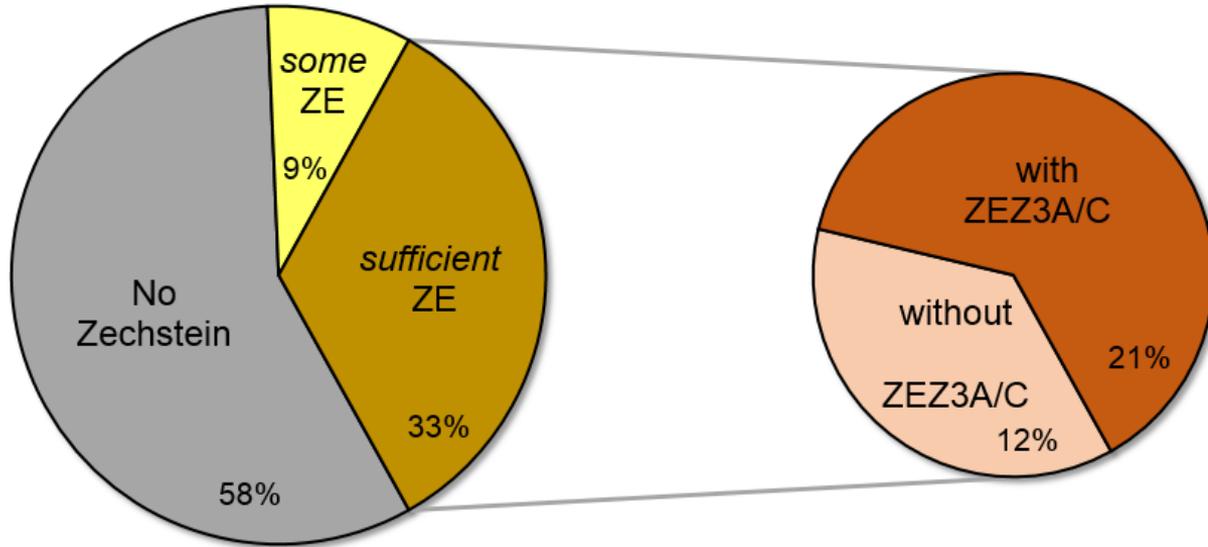


**Stringers Hit by the Bit:**  
**understanding Drilling Hazards**  
**by using the**  
**Geo-Drilling Events Database**

# Contents

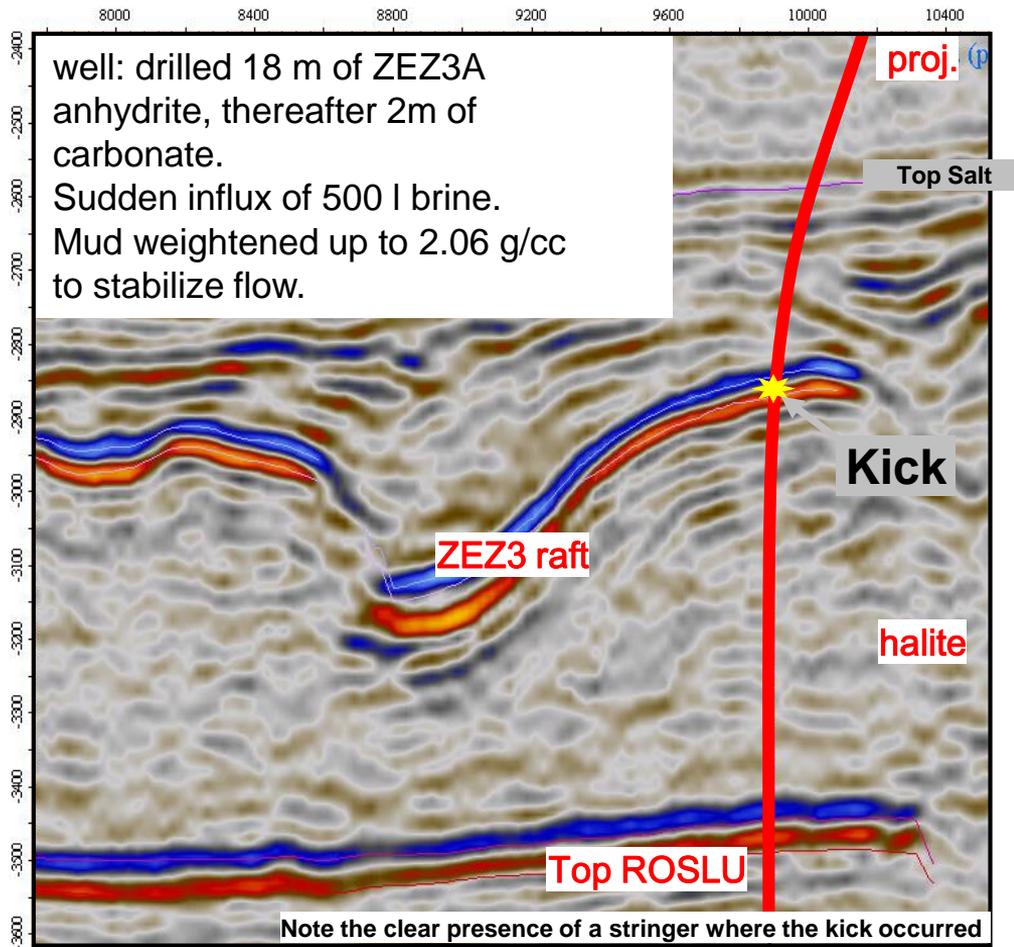
- Background
- Geo Drilling Events Database
- Stringers in the GDE DB
- Conclusions
- Questions

# How many Stringer hits?

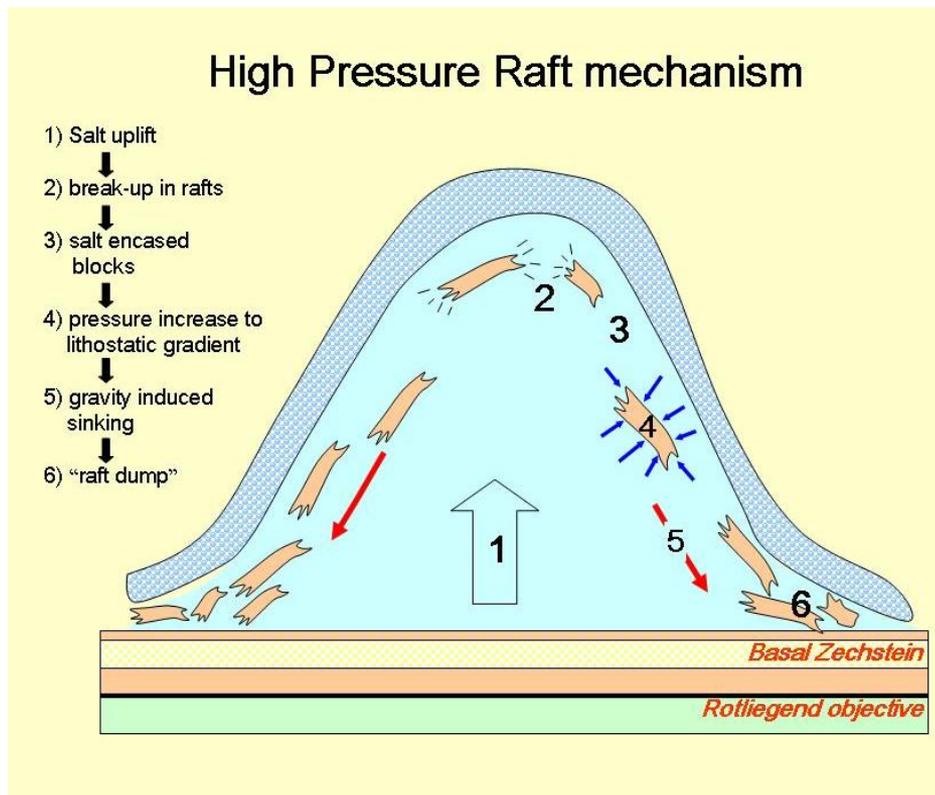


- From 6011 NL boreholes, 2013 are *conclusive* and 1284 observed ZEZ3A/C
- Many recordings of Stringer drilling incidents; but how many?

# Example #1

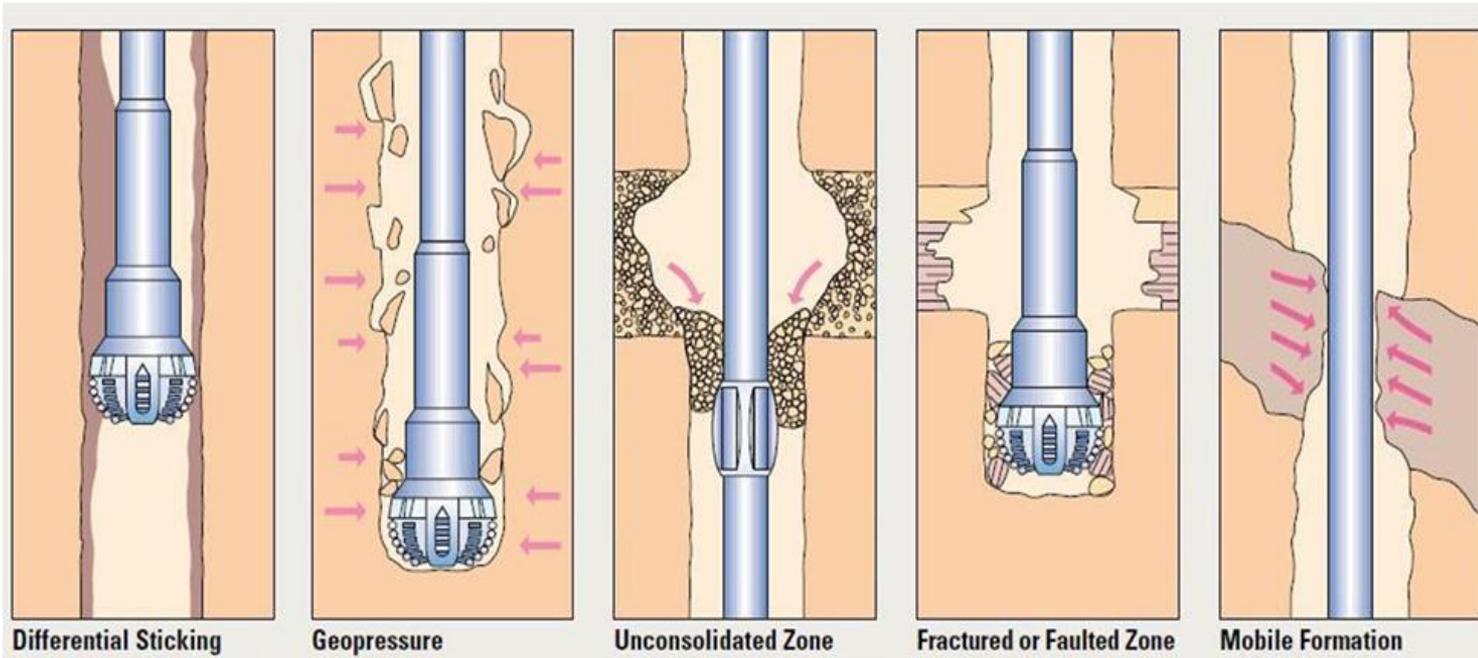


# Zechstein stratigraphy: -post deformation-



# Drilling Hazards:

Important cause of Non Productive Time



*Stringer kick*

*Squeezing salt*

# Why compiling Geo Drilling Events?

- Improving **well safety** and **well cost** related to Geological Drilling hazards: reducing NPT
- Providing a better understanding of geological drilling hazards in NL
- Learning from past geological incidents encountered by other operators by sharing information
- Using offset well data efficiently to optimize well design

# GDE DB\* Project background



**2014**

***Phase 1: Feasibility***

- TNO JIP: pilot to investigate feasibility geo-hazards database
- 11 operators participated
- Feasibility proven: EBN decided to take lead for follow-up
- Nogepa/EBN Zechstein workshop May 2014

**2015**

***Phase 2: Development***

- EBN review pilot data
- Defined GDE DB structure
- Analyses by experienced Well Engineers
- Presented to NOGEPa and received full support

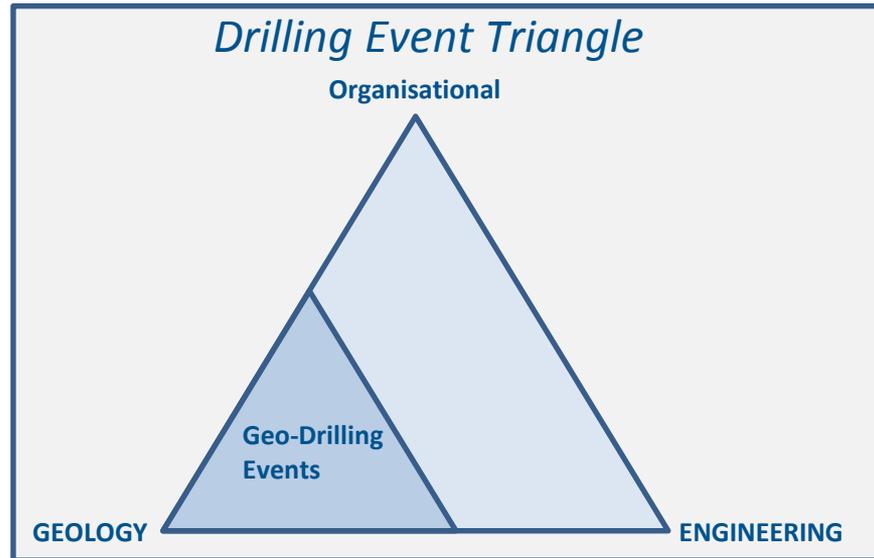
**2017**

***Phase 3: Deployment***

- EBN tested operational GDE DB Tool
- Roll out to Partners in August 2017

\*: Geo Drilling Events DataBase

# What Drilling Events are captured?



*Drilling Events can have one -or more-causes!*

- *Geo-Drilling Events have a significant geology component in the cause*
- *„ „ require geoscientists for understanding*
- *„ „ can often be avoided by doing geological homework*

# Geo-Drilling Events Database

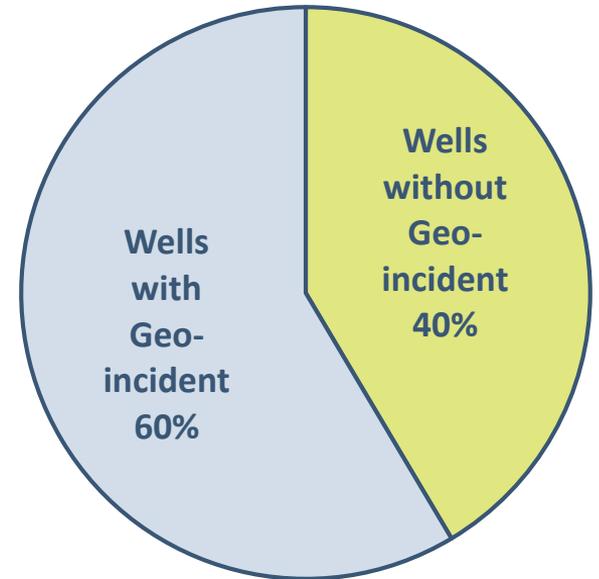
Well Name	Well Attributes (Well Name)	Operator	License Number	Well Category	Year of Install	Well Inspector	Surface coordinate (UTM/Easting)	Surface coordinate (UTM/Northing)	Geological location	Well Class	Classification	Short description	Narrative Summary	Incident START date	Incident END date (Approximate)	Incident START depth	Incident END depth if appropriate	Incident START depth	Incident END depth if appropriate	Stratigraphic unit (if different from well)	Stratigraphic unit (if different from well)	Was well direction between incident START-END depth?	Calculation Method	Geological Hazard	Reference
1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
101-01	101-01	101-01	101-01	101-01	101-01	101-01	101-01	101-01	101-01	101-01	101-01	101-01	101-01	101-01	101-01	101-01	101-01	101-01	101-01	101-01	101-01	101-01	101-01	101-01	

**Data types:**

1. Generic well data
2. Geo-Drilling Events (*facts*)
3. Geo-Drilling Hazards (*interpretations*)
4. Reference

# Results To Date\*

- Number of boreholes analyzed 796
- Boreholes with Geo-Events 557
- Number of Geo-Events 841
- Wells with Insufficient data 79

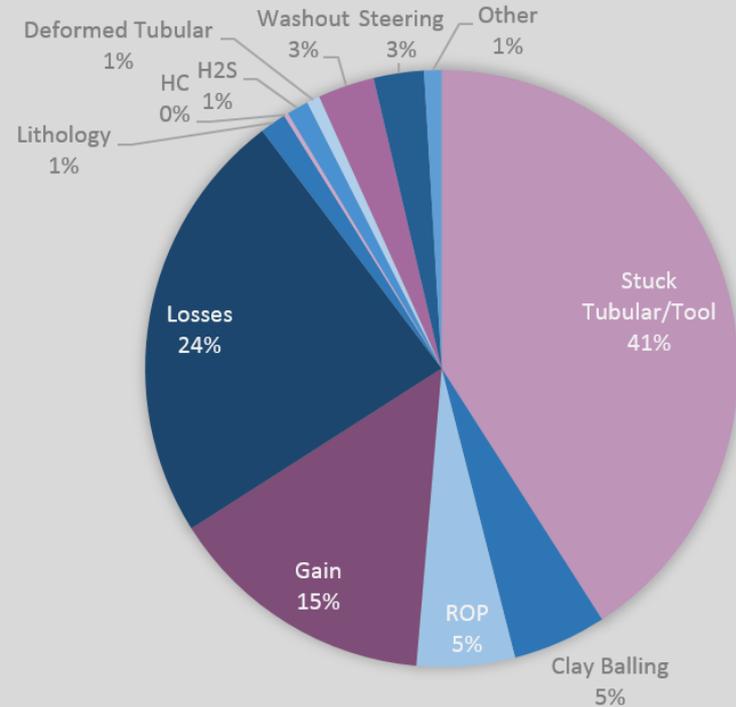


\*statistics as per jan 2018

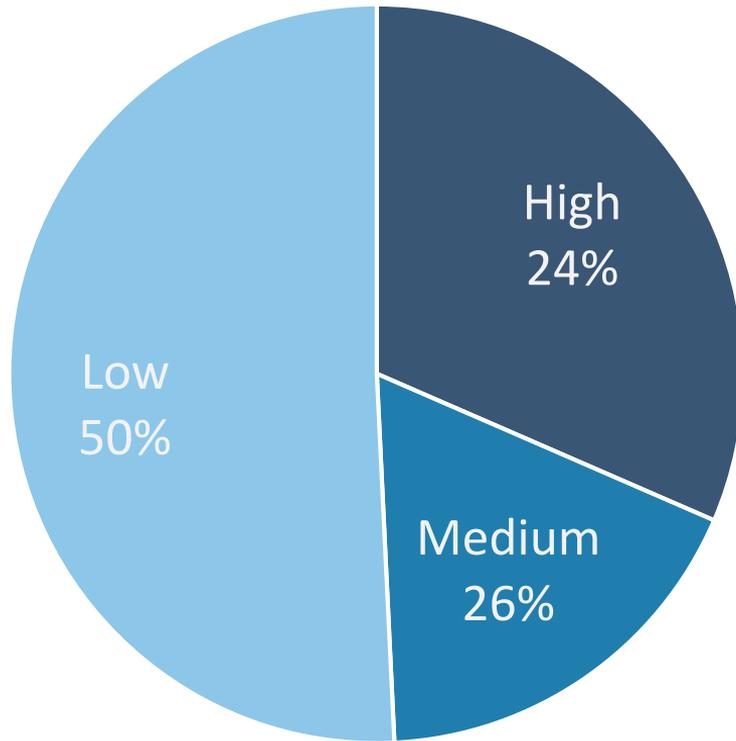
# Geo-Drilling Events

1	Stuck Tubular/Tool	344
2	Clay Balling	43
3	ROP	45
4	Gain	123
5	Losses	199
6	Lithology	12
7	HC	2
8	H2S	10
9	Deformed Tubular	6
10	Washout	26
11	Steering	23
12	Other	8

Total: 841



# Geo-Drilling Events: severity\*

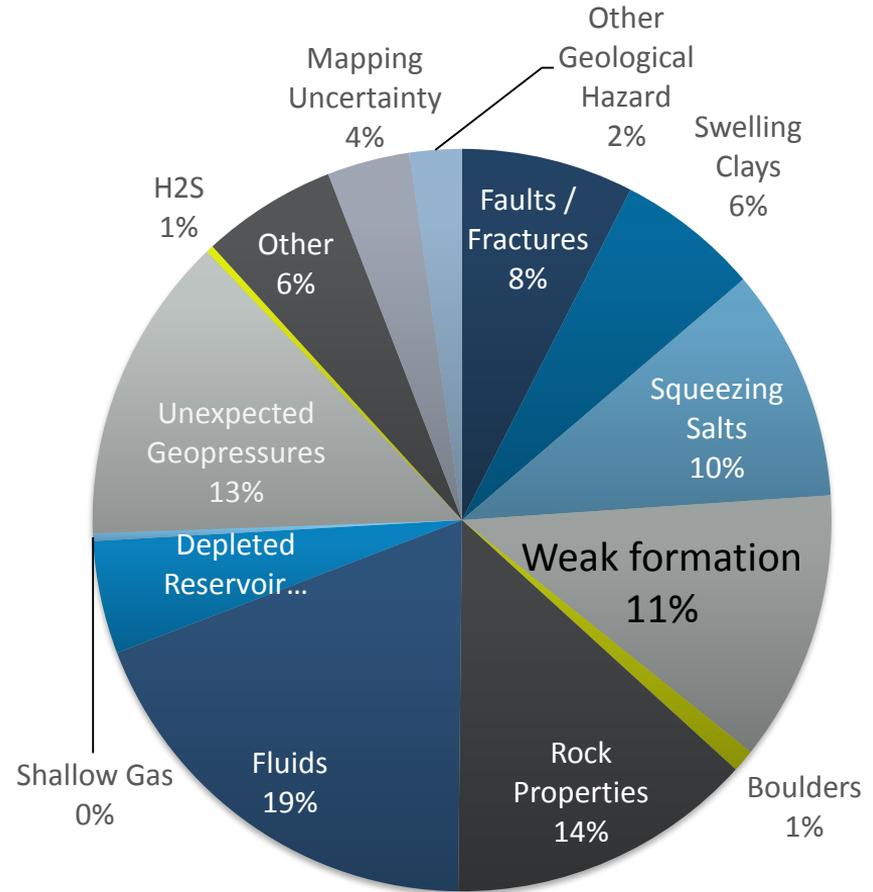


\*statistics as per nov 2017

Severity of incident:  
Semi-quantitative classification  
based on NPT and (potential) impact.

# Geo- Drilling Hazards\*

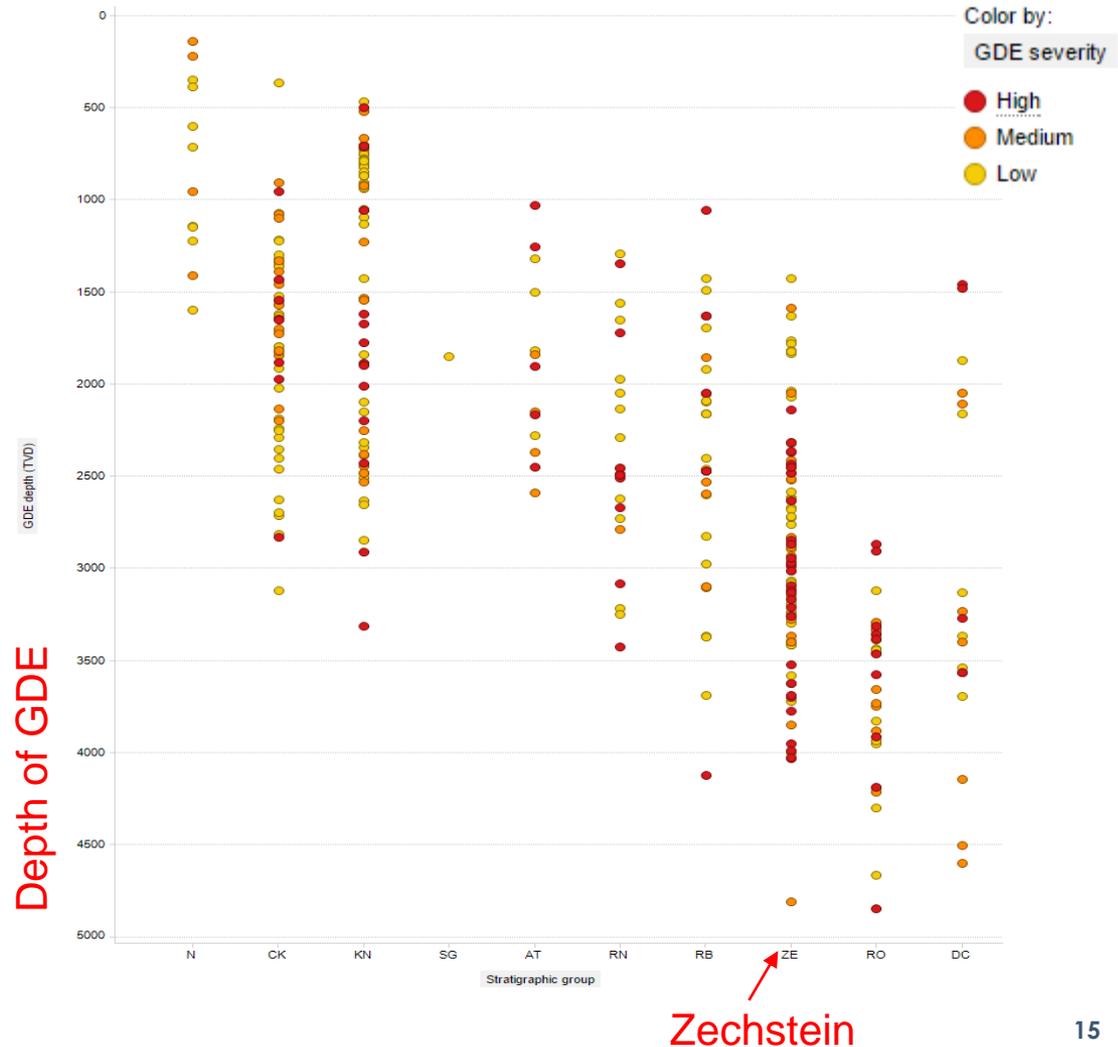
<b>Rocks</b>		<b>462</b>
F	Faults / Fractures	55
C	Swelling Clays	153
S	Squeezing Salts	75
W	Weak Formations	102
B	Boulders	4
R	Rock Properties	73
<b>Fluids</b>		<b>110</b>
D	Depleted Reservoir	18
E	Shallow Gas	4
G	Unexpected Geopressures	84
H	H2S	5
<b>Other</b>		<b>91</b>
M	Mapping Uncertainty	15
Z	Other Geological Hazard	76



\*statistics as per nov 2017

# GDE DB provides insight

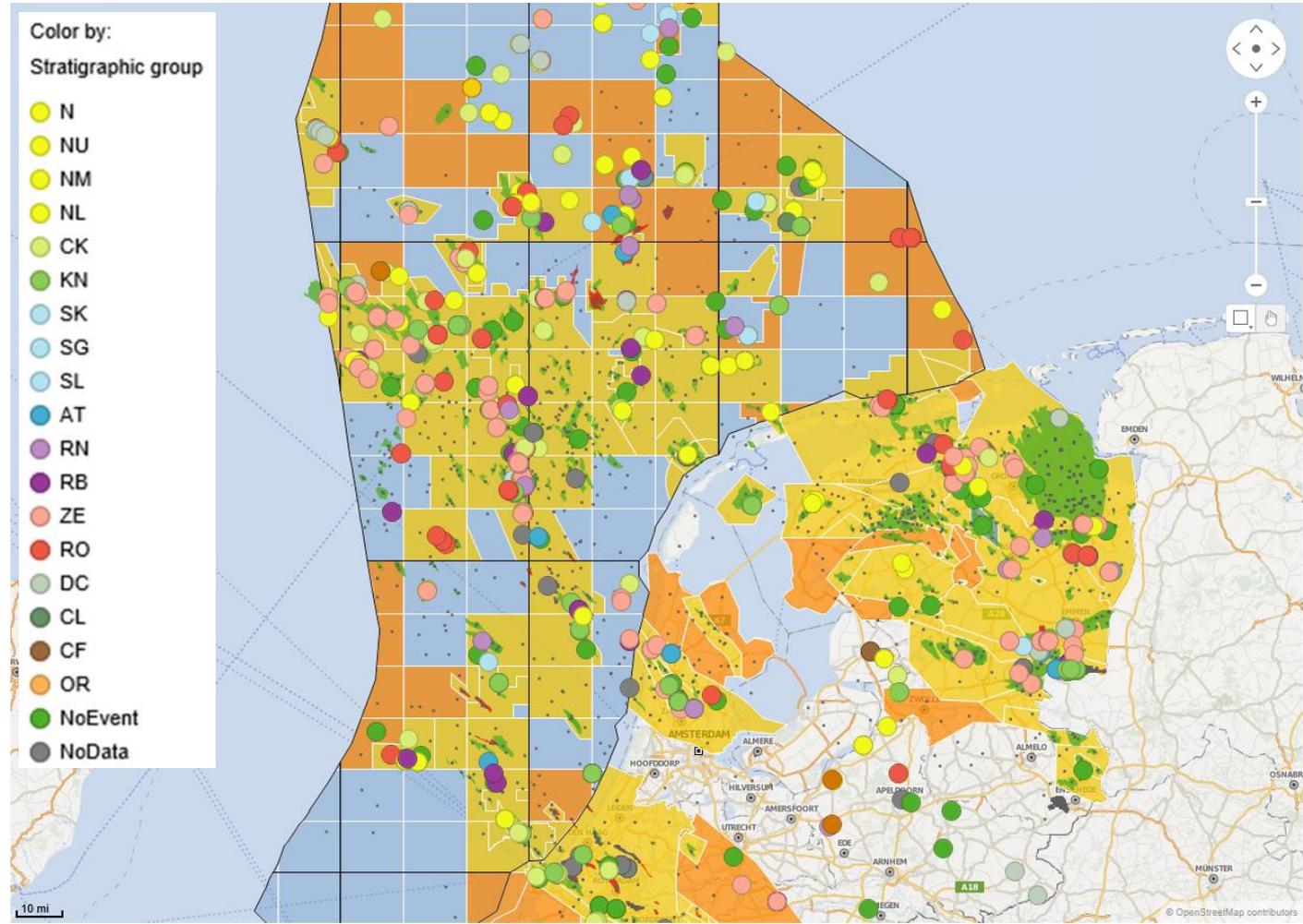
- GDE's plotted as function of:
  - -depth,
  - -stratigraphy,
  - -severity
  - etc.



## GDE DB mapview:

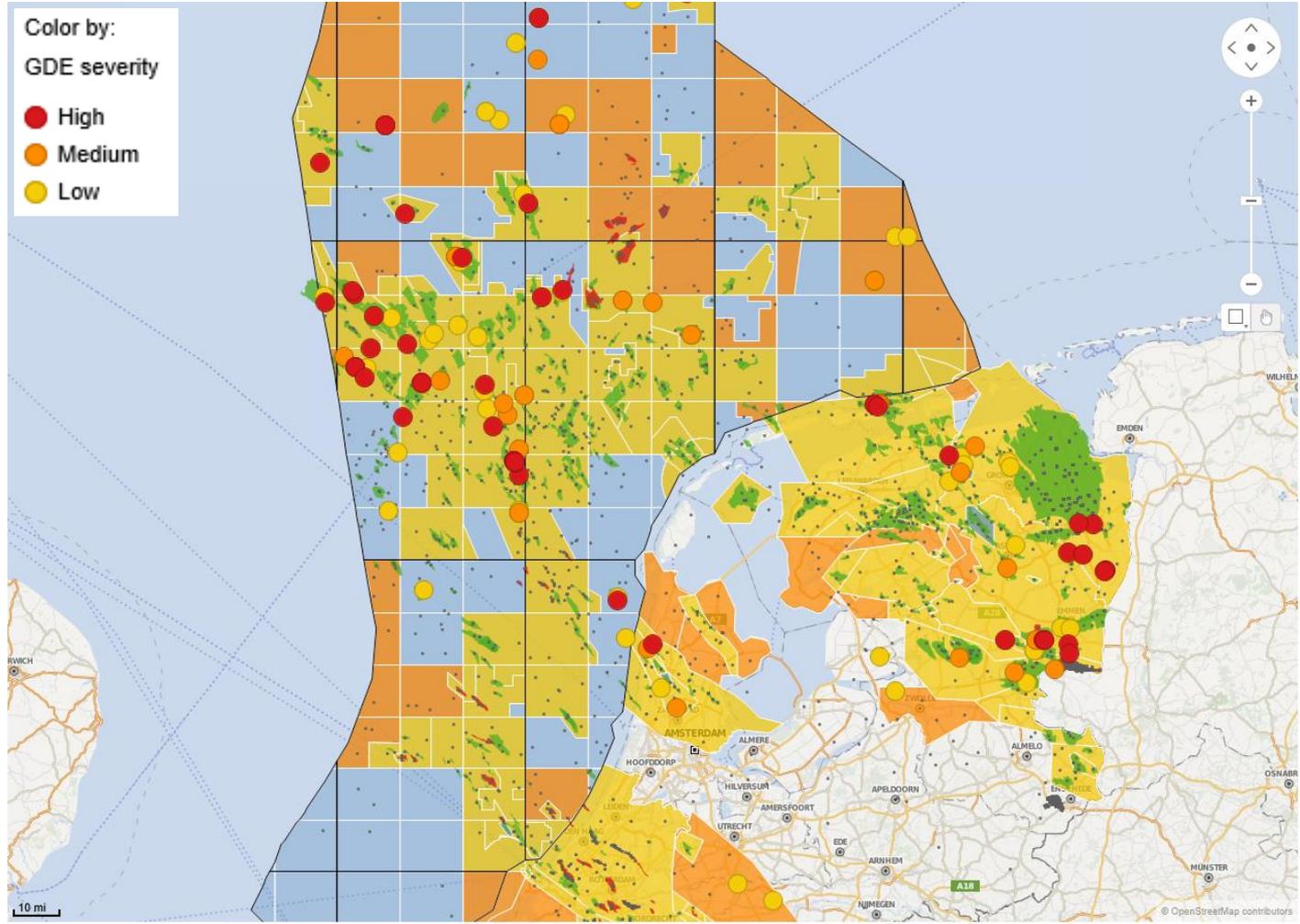
- Licences
- Events

*Events  
colorcoded by  
stratigraphy*



## GDE DB mapview:

- Licences
- ZE Events only

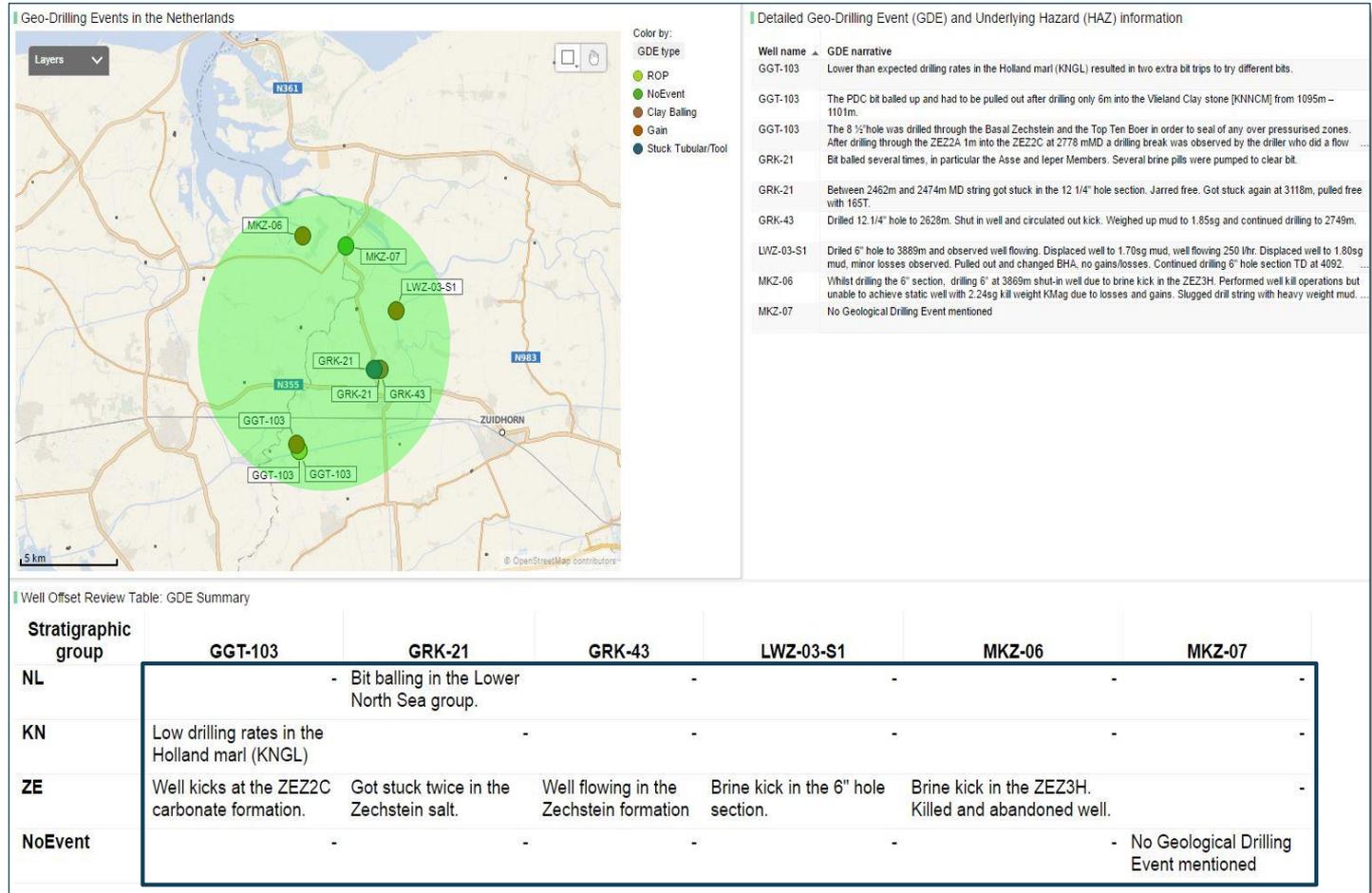


*Events  
colorcoded by  
severity*



# GDE DB offset well view:

- All GDE info for selected wells



# summary

- 1) Geo Drilling Events Database uses classification system for *drilling observations* and *geological interpretations* causing the GDE's.
- 2) Around 800 NL boreholes analyzed (and increasing).
- 3) Convenient user-interface based on webhosted Spotfire project.
- 4) GDE DB accessible for EBN partners.
- 5) GDE DB allows de-risking new well designs now.
- 6) GDE DB starting point for further research.