

Anticipating Drilling Hazards

by Sharing

Geo-Drilling Events Information Nationwide

Guido Hoetz

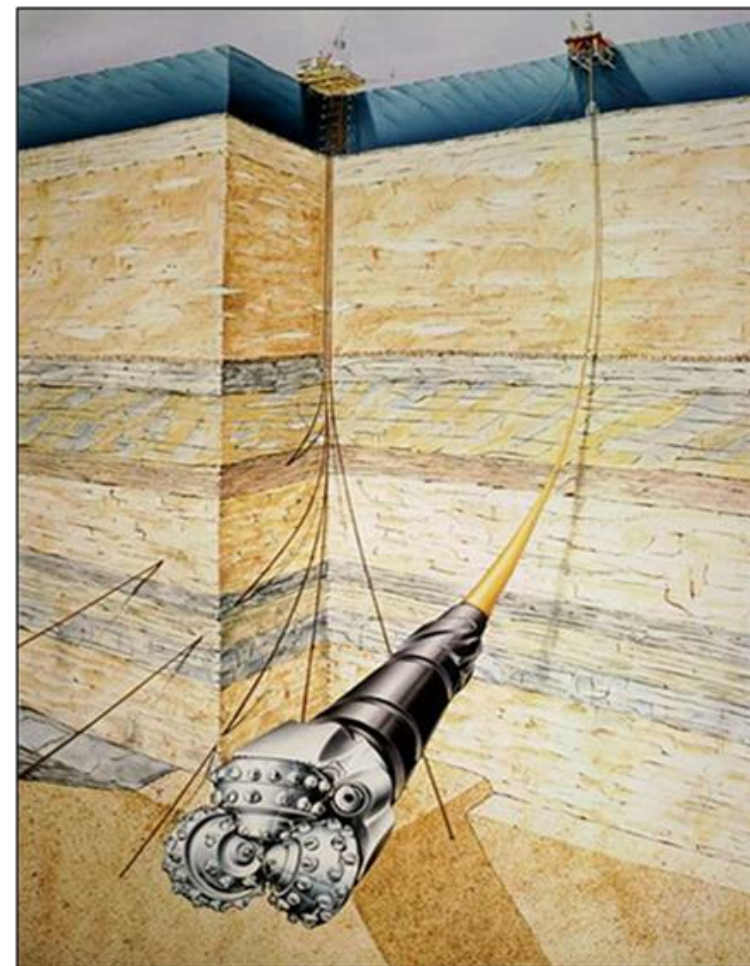
Ivo Nijhuis

EBN B.V. The Netherlands

WellSpec „ „

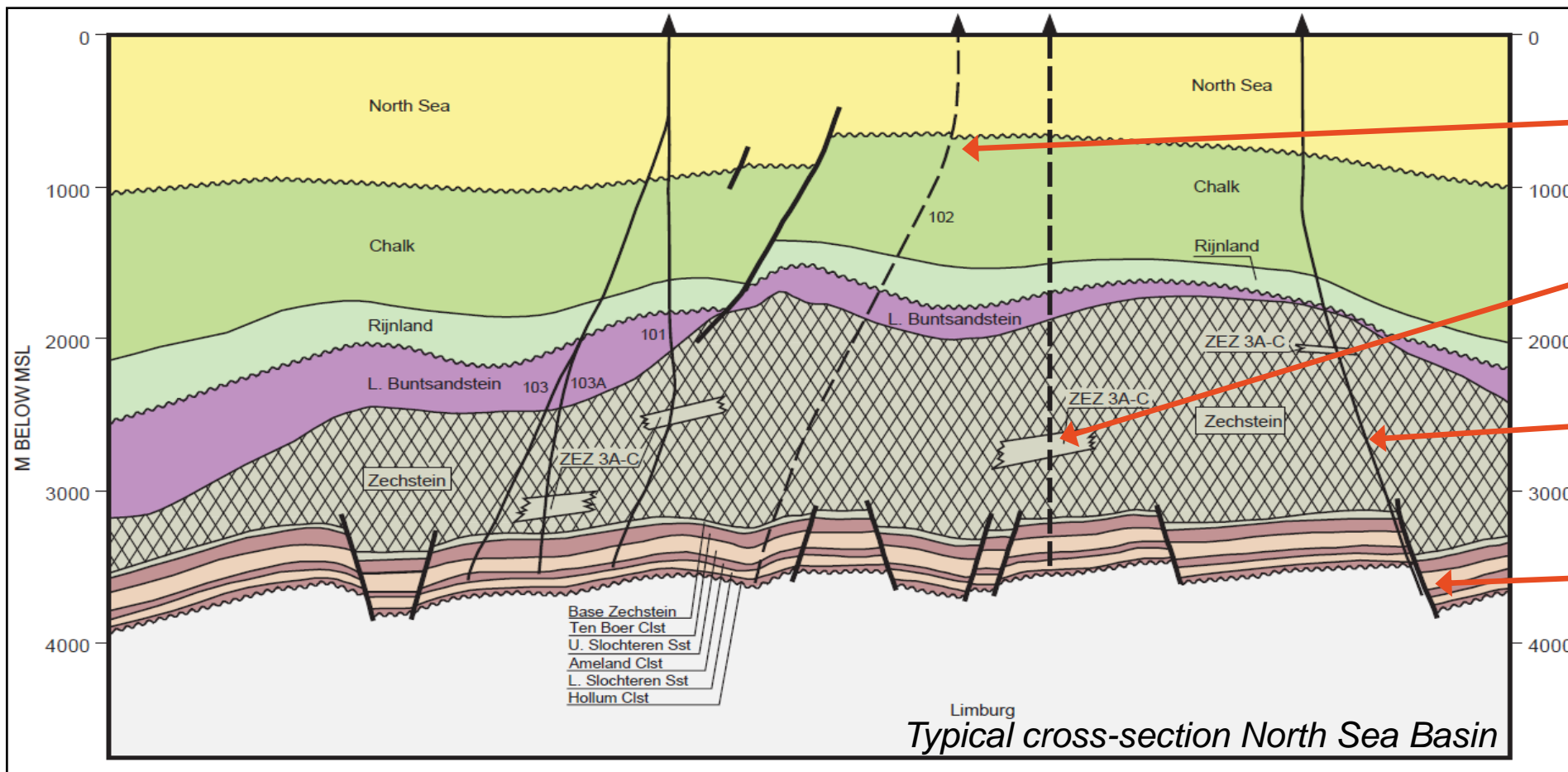
Content

- Introducing Geo Drilling Hazards
- Capturing Geo Drilling Events
- How to use the GDE Database
- Conclusions



Anticipating Drilling Hazards

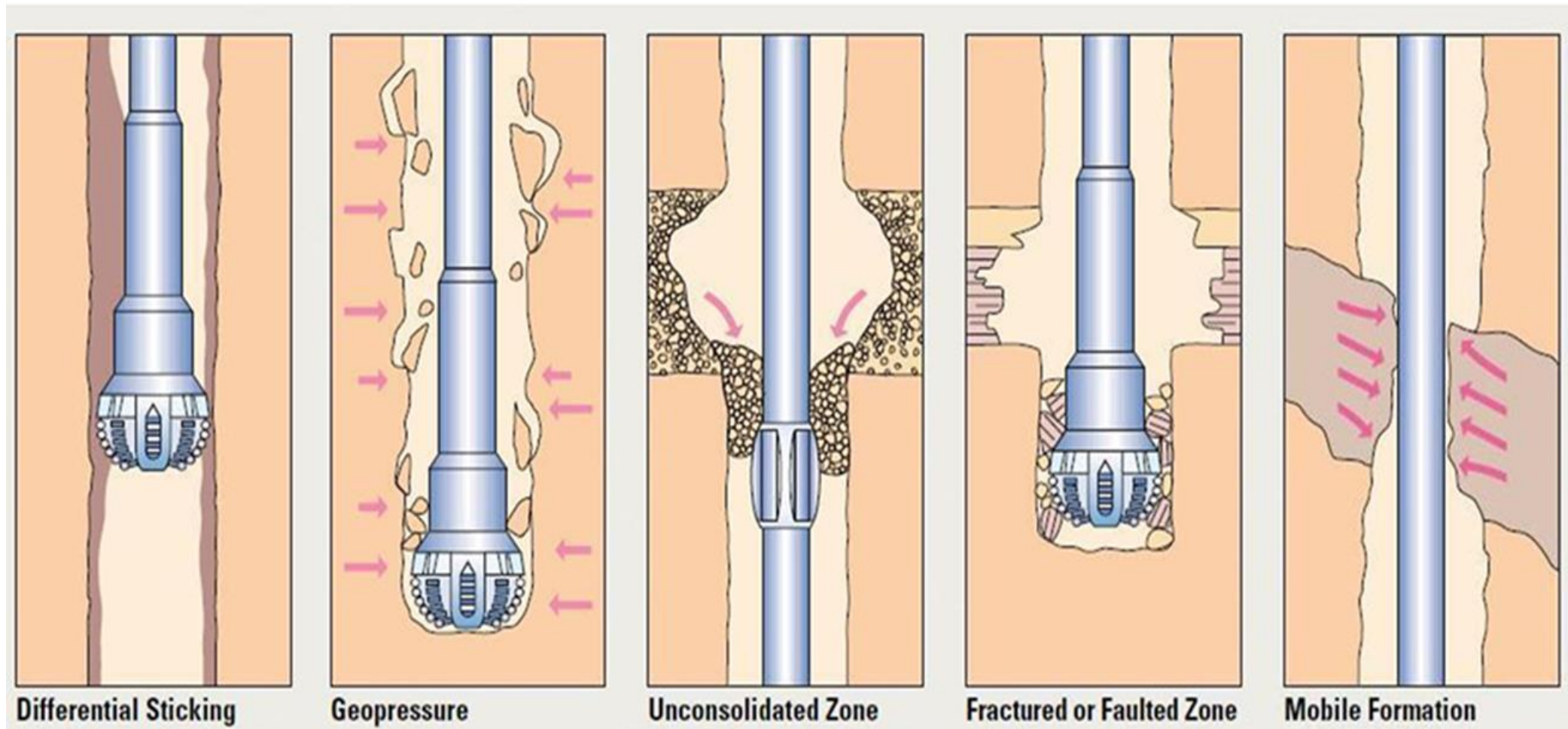
What are the geological considerations required to support **safe & effective** well design + well execution?



- losses
- kicks
- stuck
- H2S

Anticipating Drilling Hazards

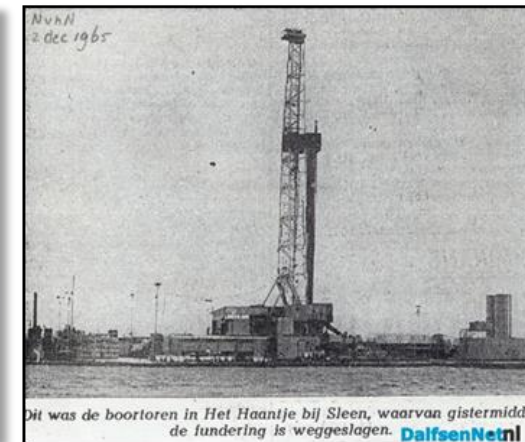
Drilling Hazards: Important cause of *Non Productive Time*



Anticipating Drilling Hazards

Hazard happens...

- Blow-out in Het Haantje 1965
- Unexpected over-pressured gas accumulation encountered at 1950m
- **Gas kick** was not contained and gas mobilized upwards
- Once pressure exceeded fracture strength of mechanically weaker shallow sediments gas escaped
- No injuries but the drilling rig and portacabins sunk into the ground



Anticipating Drilling Hazards

Why compiling *Geo Drilling Events* systematically?

Improving **well safety** and **well cost** related to Geological Drilling hazards: reducing NPT via:

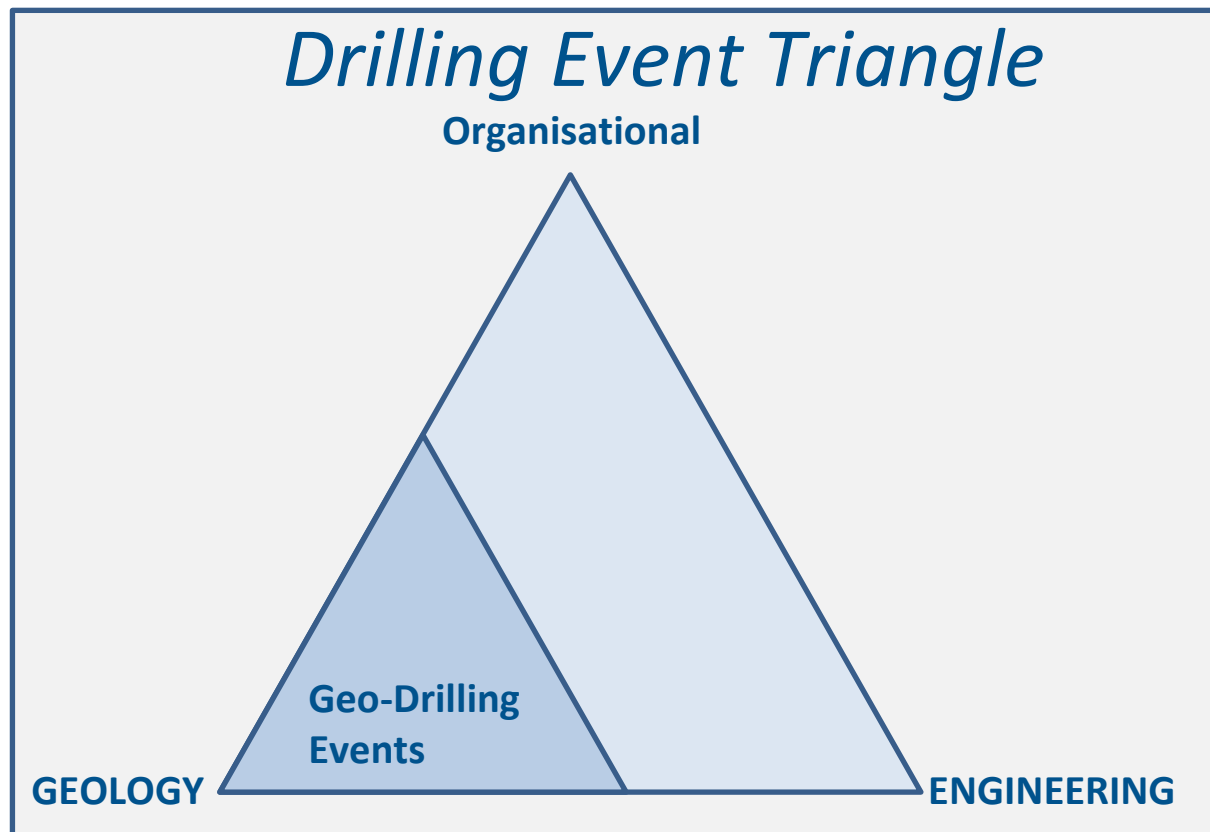
- Providing better understanding of geological drilling hazards in NL
- Sharing information: learning from past geological incidents encountered by other operators **including newcomers**
- Using offset well data efficiently to optimize well design



ebn

EBN: Dutch state company investing in NL Oil/Gas and Geothermal is in excellent position to coordinate this initiative.

Anticipating Drilling Hazards



*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: structure

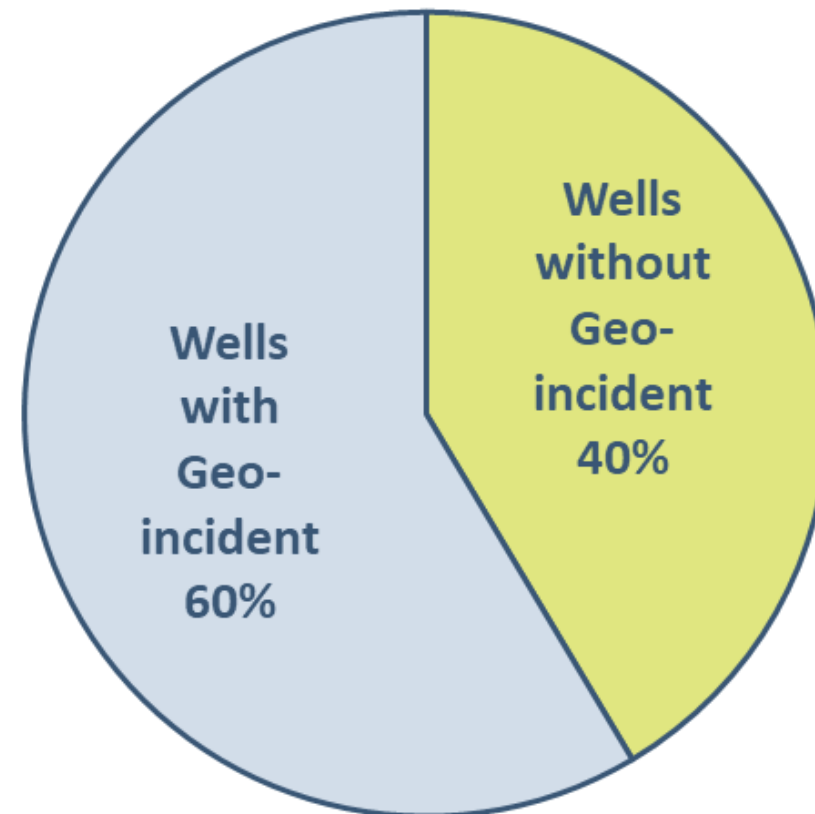
Well Data	Well Metadata from W井/ TDH	Geological Incident	Geological Hazard	Reference
1	Operator Licence Name/Number Well category Year of opud Well trajectory Surface coordinates (UTM32-E205) Surface coordinates (UTM32-E205)	2 Incident Code Classification Short description Narrative Summary	3 Geological Hazard Geological Hazard narrative summary	4 Reference Reference and extract from mud summary
P11-A-02	Canada (Dana Petroleum) ME/EP/AM4020304 D 2006 deviated 585230 522300	2 L/M/H Bit Bailing, reactive clays in N.Sea Group. Many wells in P11 and DNS suffer this problem. Well TD is 200m shallow, target reservoir exposure reached	3 narrative summary	4 Reference and extract from mud summary
P11-03	Petro-Canada (Dana Petroleum) ME/EP/AM4020304 E 2011 E/LOG/MW/98038934	N N N/A		
P11-C-01	Dana Petroleum ME/EP/AM4020304 D 2011	N TRI-LATERAL WELL Failure of MSFC stage cementing equipment. Several remedial squeeze jobs required. No geological based incidents.		
P22-A-03	Veba Oil (Dana Petroleum) 38270/989/EMK D 2001	N N/A		
P26-03	Petro-Canada (Dana Petroleum) ME/EP/AM2046714 E 2004	N N/A		
P11-04	Amoco E/EAM/30304098 E 1997	N N/A		
PLA-01	CGP Suez PLA n 1999 deviated 3934067.2 551746.4	v 4 Salt water kick in the Zechstein	G Salt water kick	Drilling reports, geological report
PLA-02	CGP Suez PLA n 2003 deviated 3934067.2 551746.4	v 16 Abandoned because of problems during the 5' liner cementation.	Z Abandoned	Drilling reports, geological report
016a-02	CGP Suez 016a D 2011 deviated 399394.9 64789.2	N 16 Motor failure	Z Stuck point	Drilling reports, geological report
016a-04	CGP Suez 016a n 2011 deviated 399394.9 64789.2	v 10 few washouts, poor Real Time GR readings	W Washouts	Drilling reports, geological report
016a-04	CGP Suez 016a D 2012 deviated 399394.9 64789.2	y 10 a few washouts in drill string @ bit depth: 2278m, 2334m, 3029m, 2452m and 2602m, poor Real Time GR readings in Interval 2065m to 3221m MD - what determined to re-log hole in some intervals.	W Washouts	Drilling reports, geological report
13-0109	CGP Suez 13 D 2011 deviated 607978.6 089815.07	y 4 @ 818m stuck	G Stuck	Drilling reports, geological report
13-0109	CGP Suez 13 D 2011 deviated 607978.6 089815.07	1 1 Drilling couldn't be resumed because of drill string stuck. Worked and jarred to free it and reduce MW to 1.05 sp. After a few days of unsuccessful attempts, it was shot off and remained 104 m of BHA downhole.	D Drilling	Drilling reports, geological report
022-5571	Fluor 022 D 1981 deviated 384080.4 547075.7	y 3 drillpipe became stuck (differential sticking) It was impossible to work the pipeline free and it was decided to abandon the well.	R Unexpected lamprophyre section	Drilling reports, geological report
022-5571	Fluor 022 D 1981 deviated 384080.4 547075.7	3 3 Unexpected lamprophyre section the Basal Zechstein was found close to the expected depth.	A Unexpected lamprophyre section	Drilling reports, geological report
022-5571	Fluor 022 D 1981 deviated 384080.4 547075.7	1 1 In total 563 ft of this mixture was drilled before the drillpipe became stuck (differential sticking) it was impossible to work the pipeline free and it was decided to abandon the well.	D Drilling	Drilling reports, geological report
017a-04	CGP Suez 017 D 2012 deviated 3994702.2 523651.9	y 1 mud motor stalled and lost after drilling to 4270mMD	F poor hole stability because of abundant natural fractures	Final Geological report (June 2012)
1159-0105	CGP Suez 1159 D 2010 deviated 591703.7 622010.8	y 1 the string became stuck	Z poor hole stability due to problems in the tertiary	Final well report
1159-0105	CGP Suez 1159 D 2010 deviated 591703.7 622010.8	1 1 Due to already high torque during drilling caused by cutting fluid loss, which increased when drilling in the chalk to set the 13 3/8" casing shoe, the string became stuck.	Z poor hole stability due to problems in the tertiary	Final well report
1159-0105	CGP Suez 1159 D 2010 deviated 591703.7 622010.8	1 1 collapsed casing	S collapsed casing	Formation evaluation data
1159-0105	CGP Suez 1159 D 2010 deviated 591703.7 622010.8	3 3 Low drilling rate in the Zechstein, stuck pipe	R lamprophyre section	Drilling reports, geological report
1159-0105	CGP Suez 1159 D 2010 deviated 591703.7 622010.8	1 1 20 days due to the occurrence of almost 200 m of high strength (grouse lamprophyre) rock in the Zechstein	S stuck pipe	Drilling reports, geological report
WIT-1	NAM Drenthe E 1994 vertical 5875248 733579	Y 1 1 Soft formation, unable to achieve MD	N/A No	
WIT-1	NAM Drenthe E 1994 vertical 5875248 733579	Y 3 1 Abrasive fm.	N/A No	
WIT-1	NAM Drenthe E 1994 vertical 5875248 733579	N 6 6 drilling too deep, section TD missed	N/A No	
WIT-1	NAM Drenthe E 1994 vertical 5875248 733579	? 1 1 While RH 13 3/8" long stuck in CIGR	N/A No	
MOL-2	NAM Andel II E 1986 vertical 3747667 623291	Y 1 1 directional problems and plugged nozzles	AT AT	
MOL-2	NAM Andel II E 1986 vertical 3747667 623291	Y 1 1 Heavy raming	AT AT	
MOL-2	NAM Andel II E 1986 vertical 3747667 623291	Y 1 1 Hole problems, stuck pipe	AT AT	
MOL-2	NAM Andel II E 1986 vertical 3747667 623291	Y 1 1 Slow progress	AT AT	
SSM-4	NAM Groningen E 1986 vertical 3747667 623291	Y 1 1 directional problems and plugged nozzles	AT AT	
LNZ-3	NAM Groningen E 1986 vertical 3747667 623291	Y 1 1 Heavy raming	AT AT	
LNZ-3A	NAM Groningen E 1986 vertical 3747667 623291	Y 1 1 Hole problems, stuck pipe	AT AT	
COV-58	NAM Schonebeek E 1986 vertical 3747667 623291	Y 1 1 Slow progress	AT AT	
AME-205	NAM TER E 1986 vertical 3747667 623291	Y 1 1 directional problems and plugged nozzles	AT AT	
AME-205	NAM TER E 1986 vertical 3747667 623291	Y 1 1 Heavy raming	AT AT	
AME-205	NAM TER E 1986 vertical 3747667 623291	Y 1 1 Hole problems, stuck pipe	AT AT	
AME-205	NAM TER E 1986 vertical 3747667 623291	Y 1 1 Slow progress	AT AT	
BRM-01	NAM Andel III E 1986 vertical 3747667 623291	Y 1 1 directional problems and plugged nozzles	AT AT	
BRM-01	NAM Andel III E 1986 vertical 3747667 623291	Y 1 1 Heavy raming	AT AT	
BRM-01	NAM Andel III E 1986 vertical 3747667 623291	Y 1 1 Hole problems, stuck pipe	AT AT	
BRM-01	NAM Andel III E 1986 vertical 3747667 623291	Y 1 1 Slow progress	AT AT	

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 1000
- Boreholes with Geo-Events 600
- Number of Geo-Events 1170
- Wells with Insufficient data 80

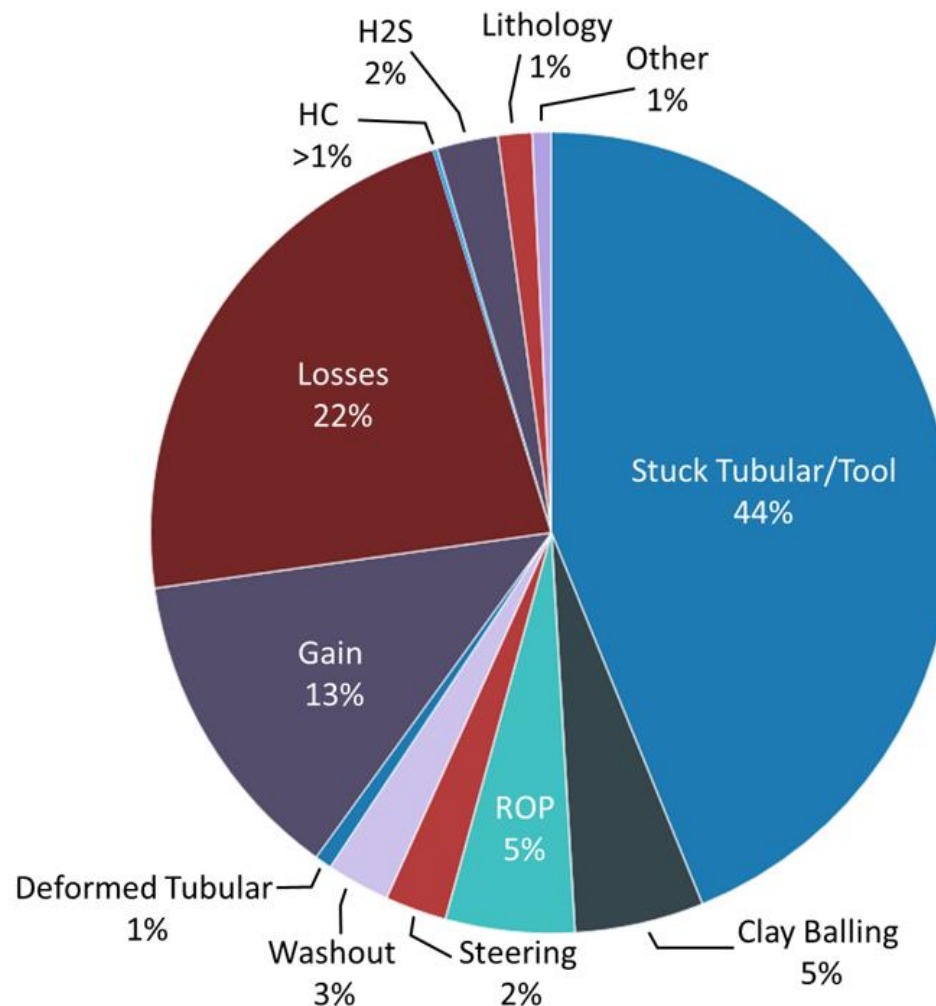


*statistics as per Sep 2019

Anticipating Drilling Hazards

Drilling Events = facts

Event types	1	Stuck Tubular/Tool	514
	2	Clay Balling	61
	3	ROP	61
	4	Gain	150
	5	Losses	263
	6	Lithology	16
	7	HC	2
	8	H2S	29
	9	Deformed Tubular	8
	10	Washout	30
	11	Steering	29
	12	Other	9
		Total events	1172

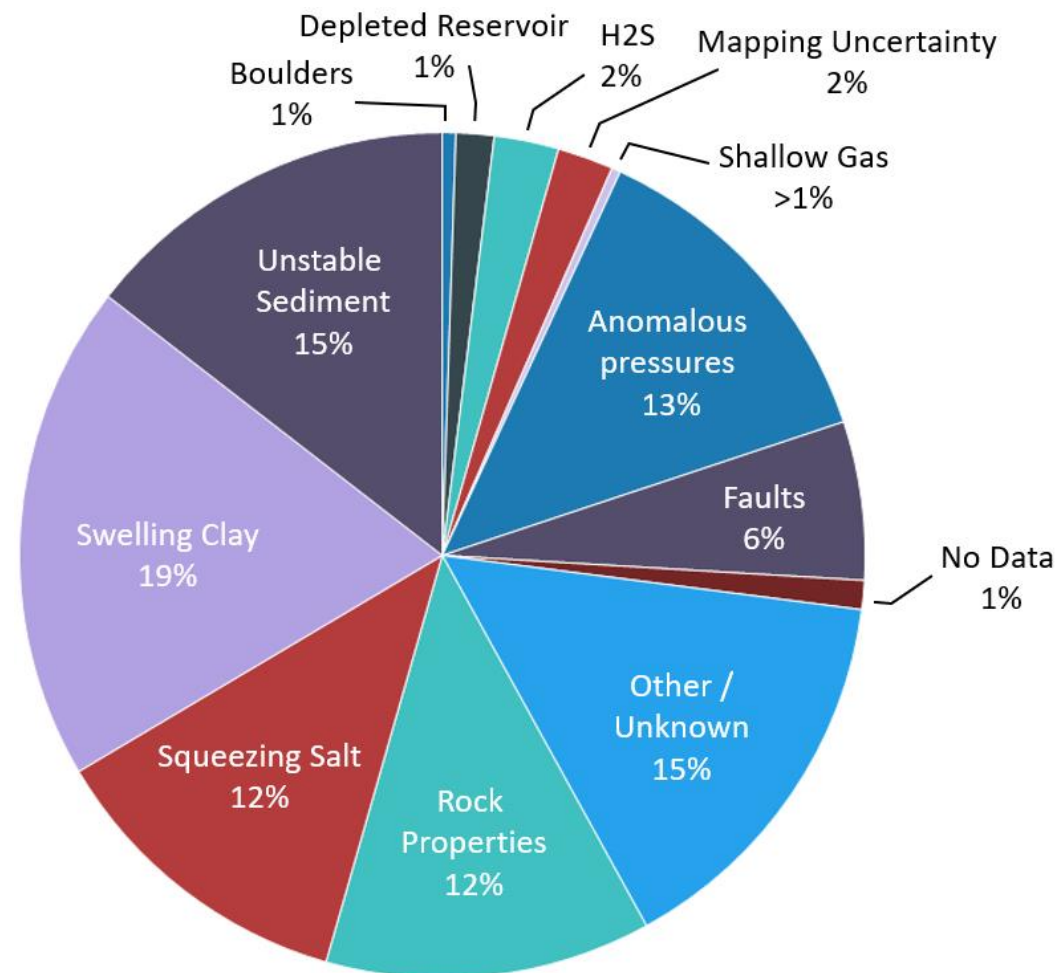


classification is key!

Anticipating Drilling Hazards

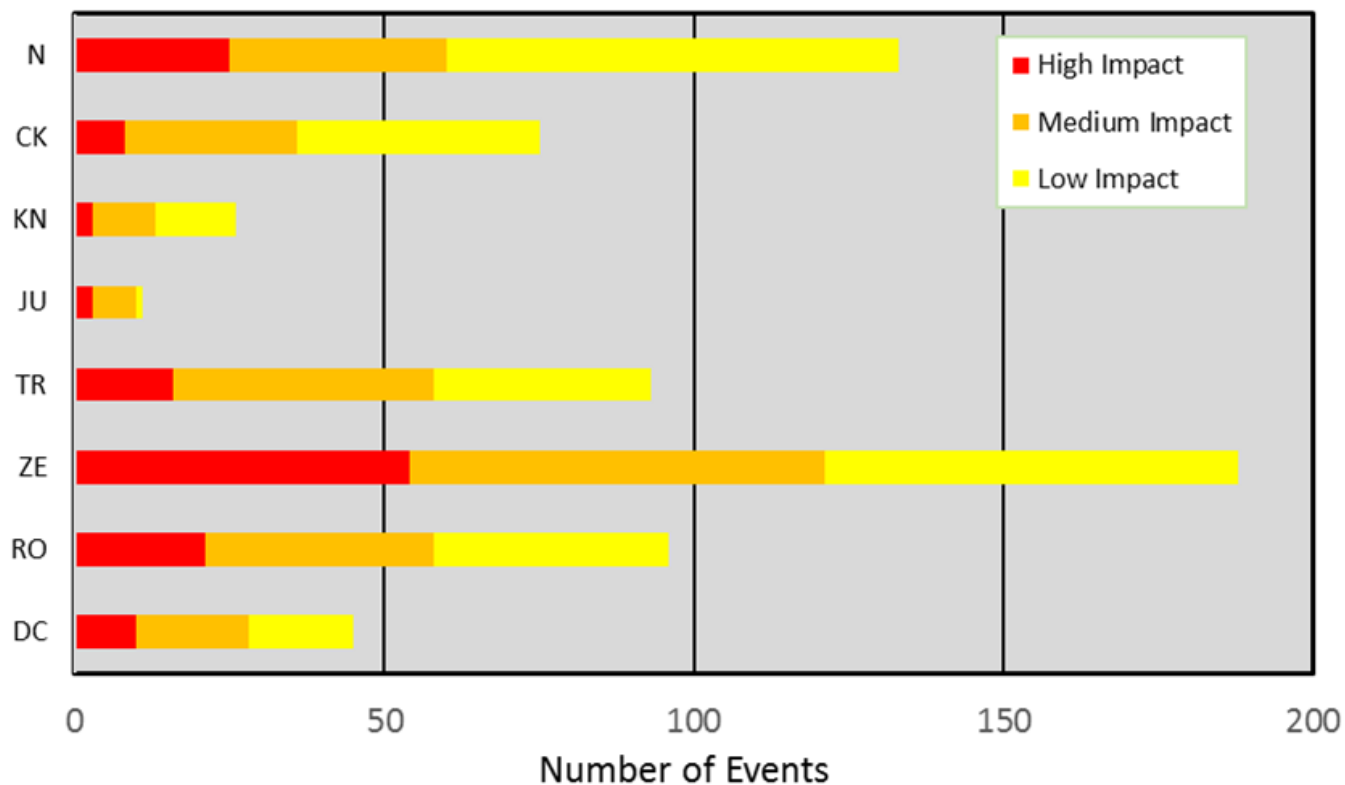
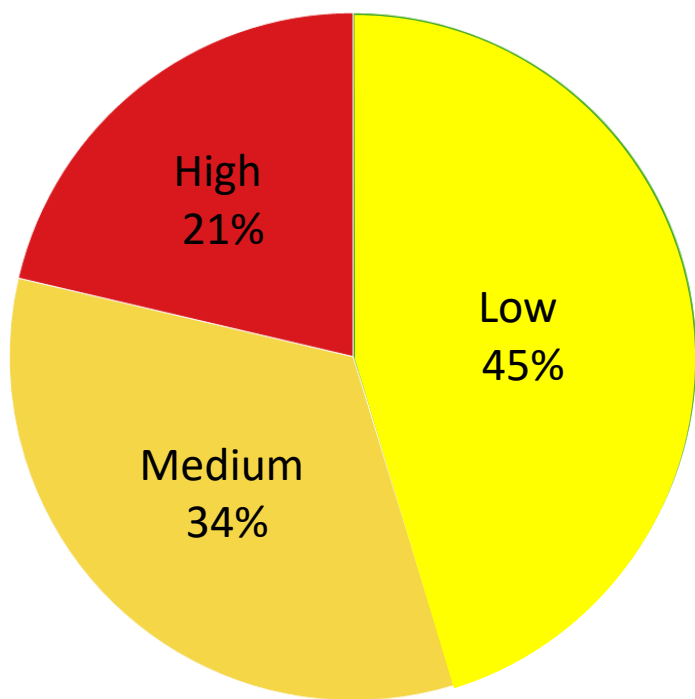
Geo hazards = geo interpretation

rocks	Faults	71
	Swelling Clay	223
	Squeezing Salt	141
	Unstable Sediment	170
	Boulders	6
	Rock Properties	146
fluids	Depleted Reservoir	17
	Shallow Gas	4
	<u>Anomalous Pressures</u>	152
	H2S	29
other	Mapping Uncertainty	25
	Other / Unknown	175
	No Data	13
Total		1172



classification is key!

Incident severity



Severity of incident:

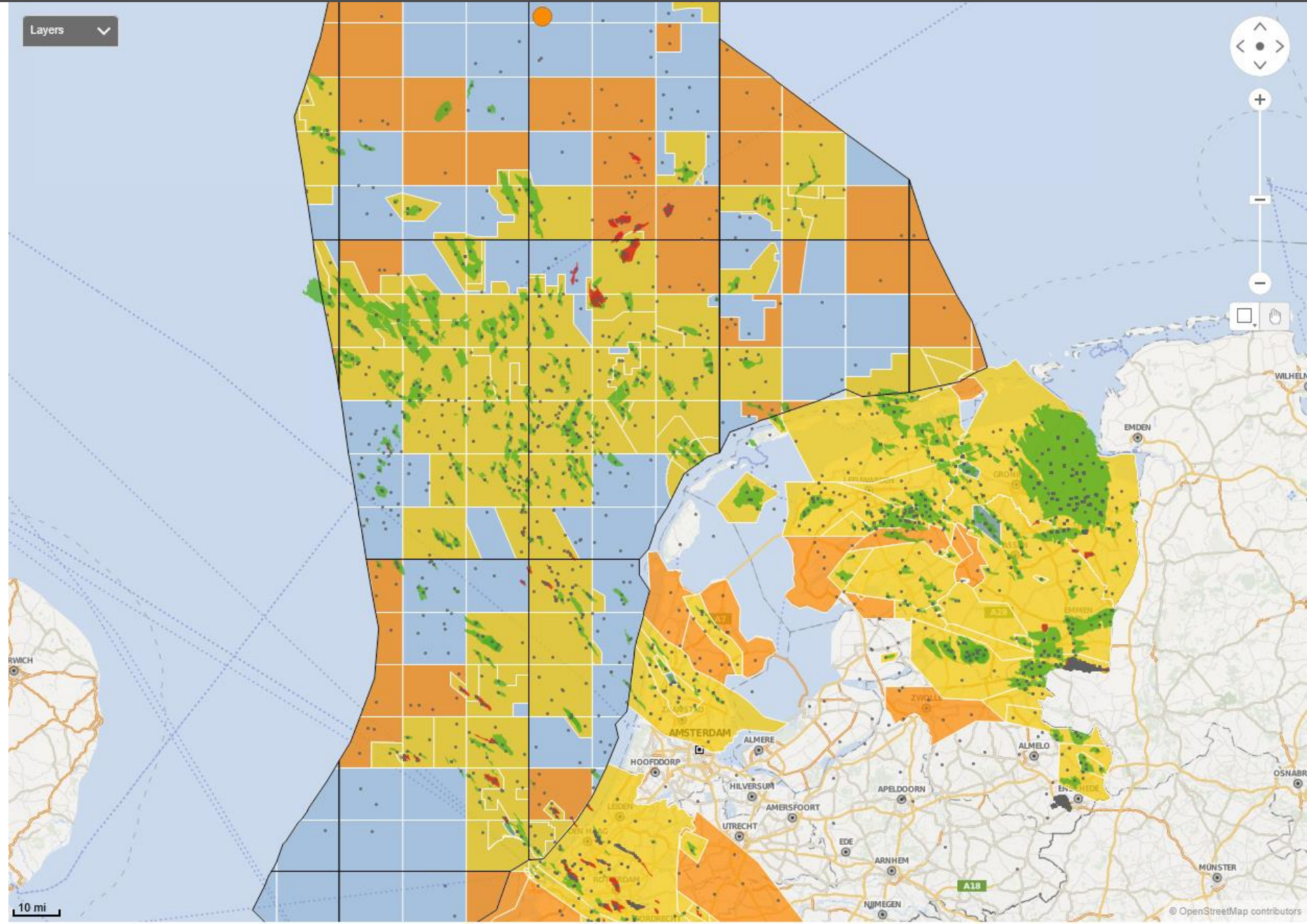
Semi-quantitative classification based on NPT and (potential) impact.

classification is key!

Example 1

GDE DB mapview:

- licences

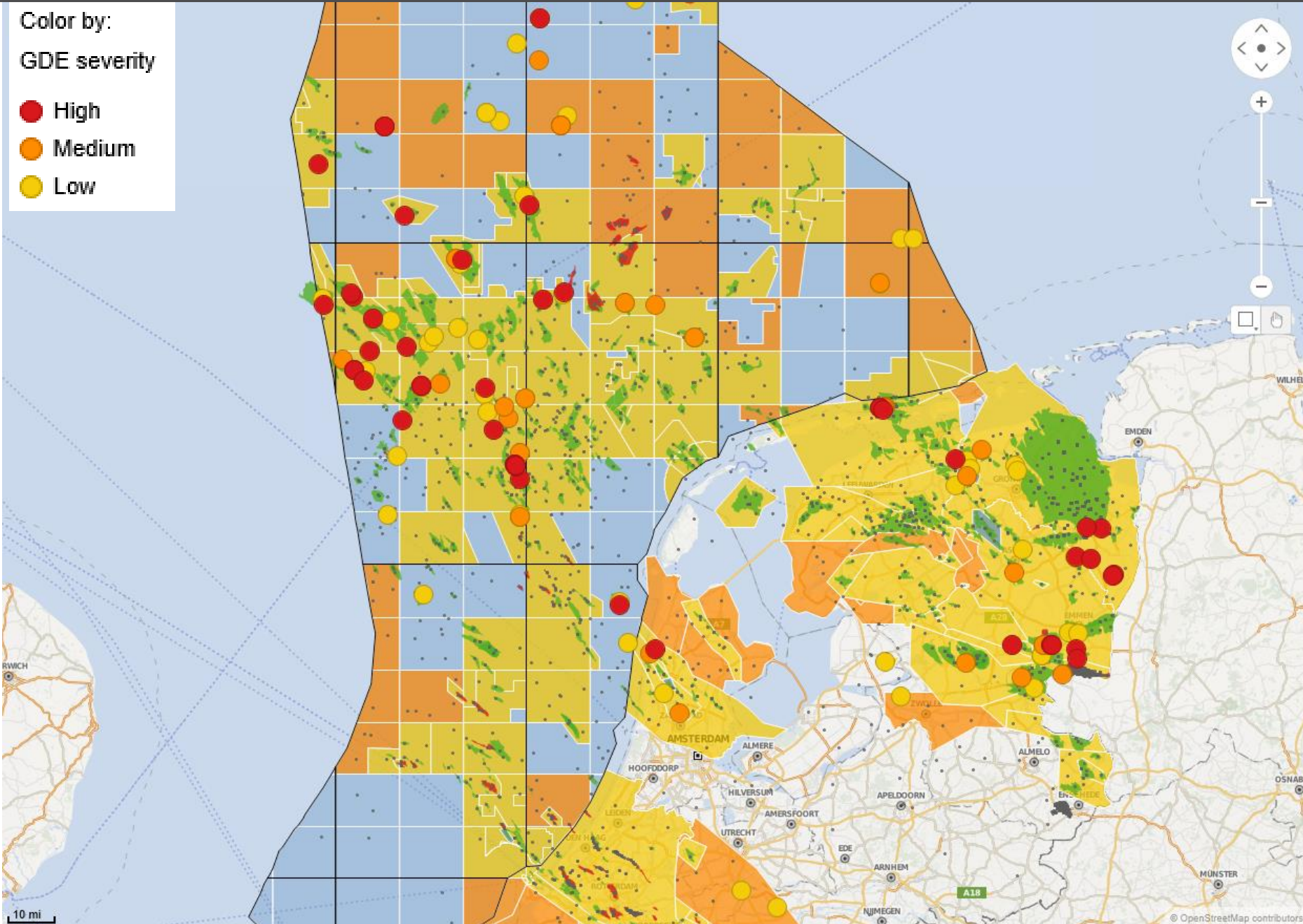


*Multiple
information layers
can be selected*

Example 3

GDE DB mapview:

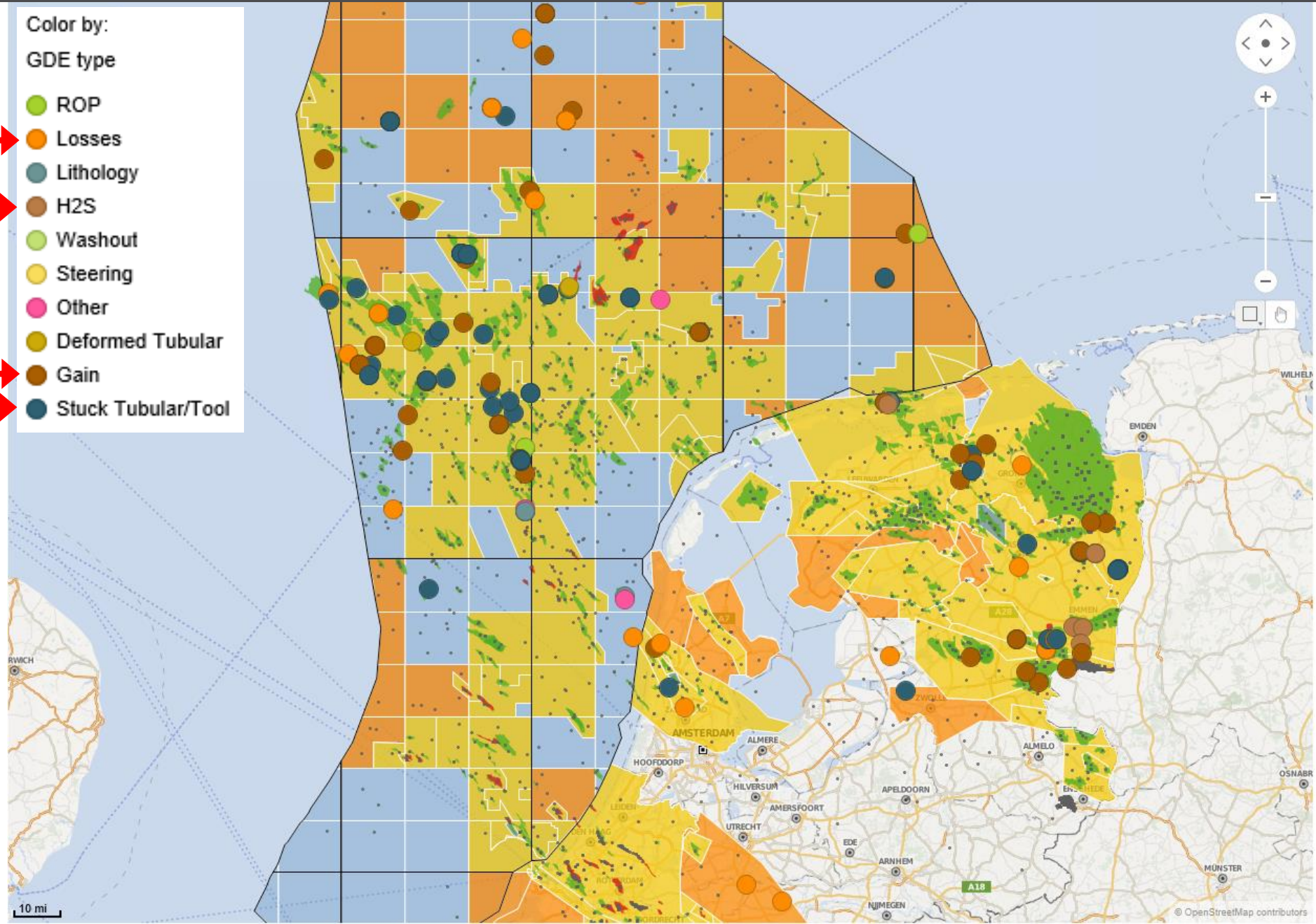
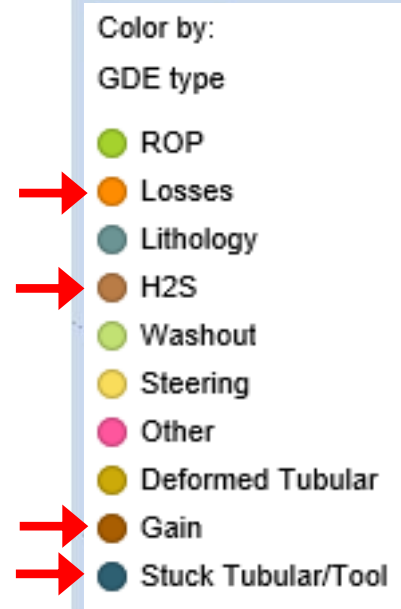
- Licences
- ZE Events only



Example 4

GDE DB mapview:

- Licences
- ZE Events only



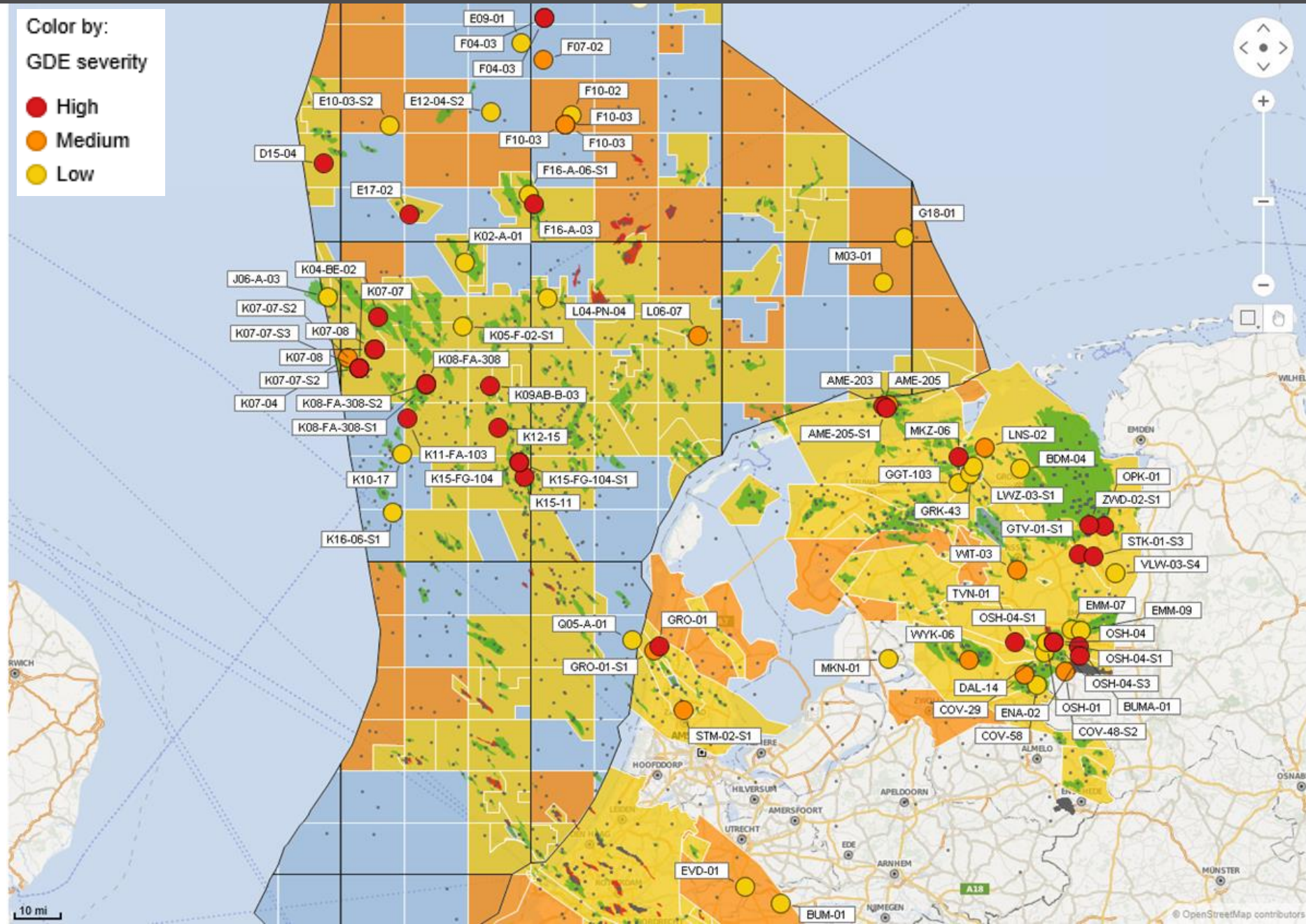
*Key events:
Kicks,
losses,
stuck tool*

Example 5

GDE DB mapview:

- Licences
- ZE Events only
- Gains/losses/
only

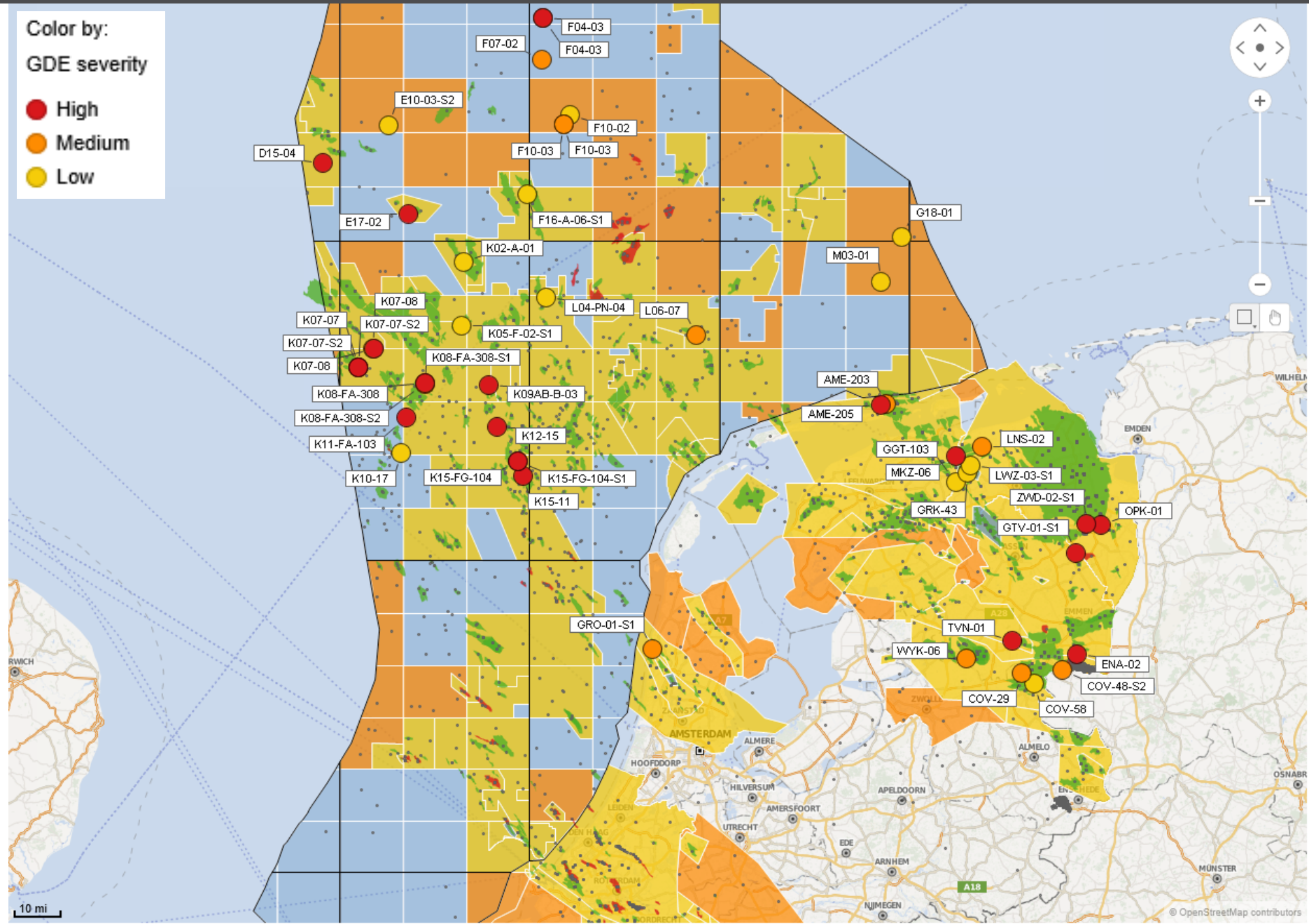
83 cases



Example 6

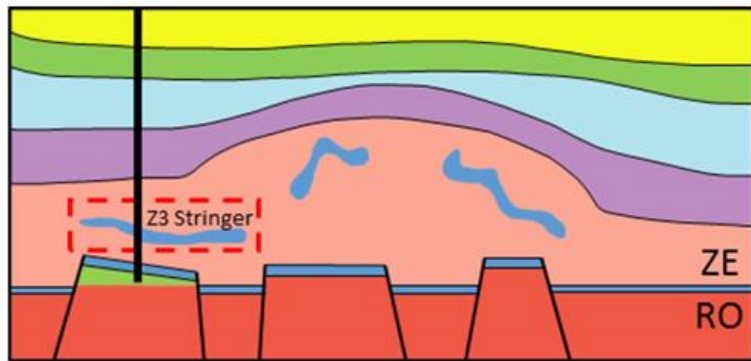
GDE DB mapview:

- Licences
- ZE Events only
- Gains only

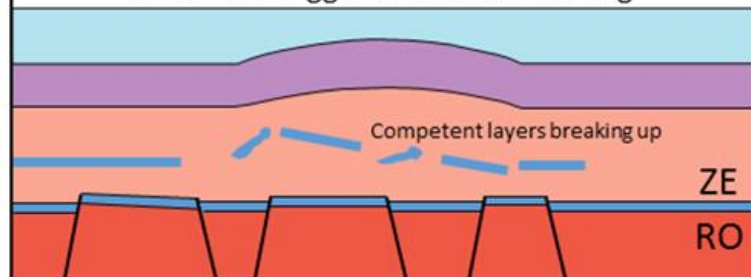


57 cases
Zechstein kicks

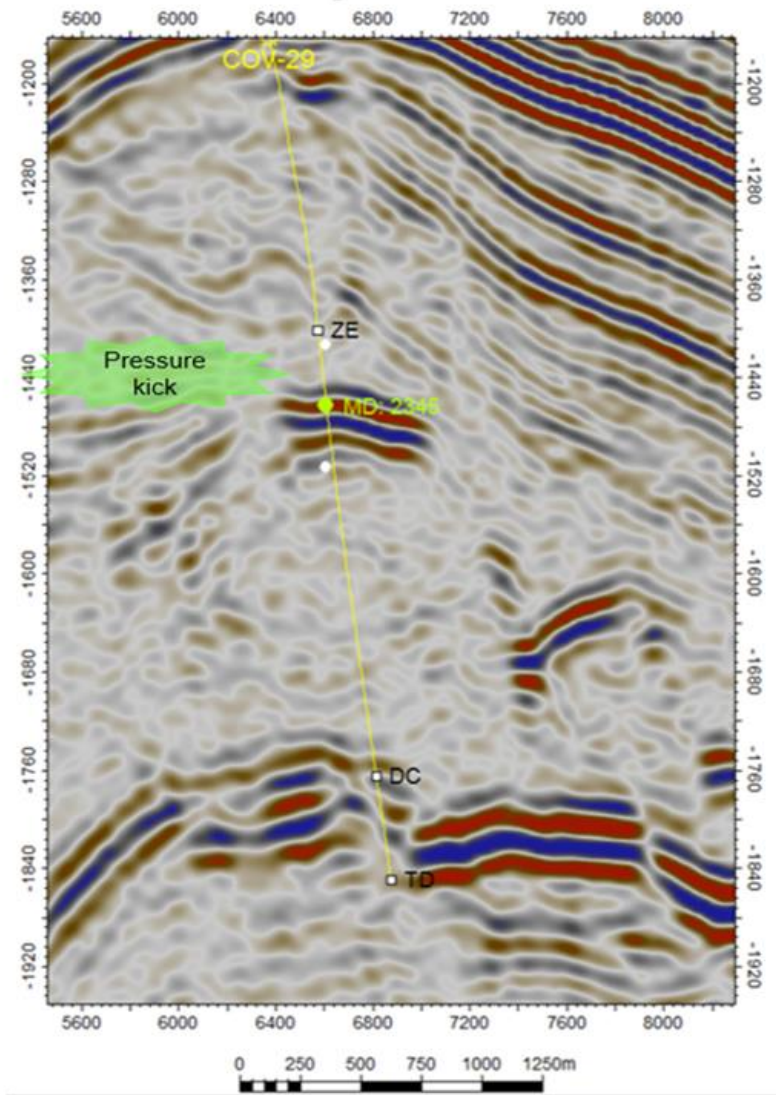
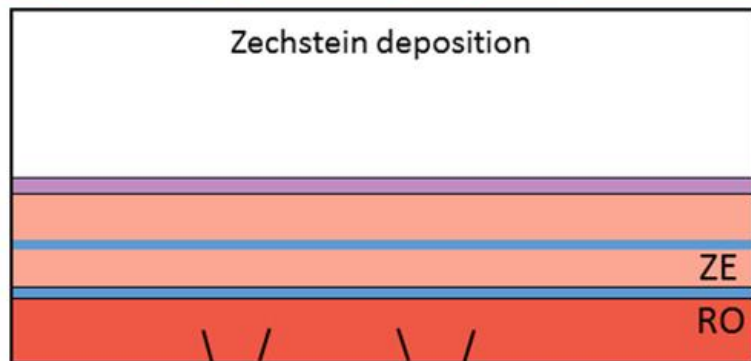
Anticipating Drilling Hazards



Subsalt faulting initiates halokinesis which will trigger differential loading



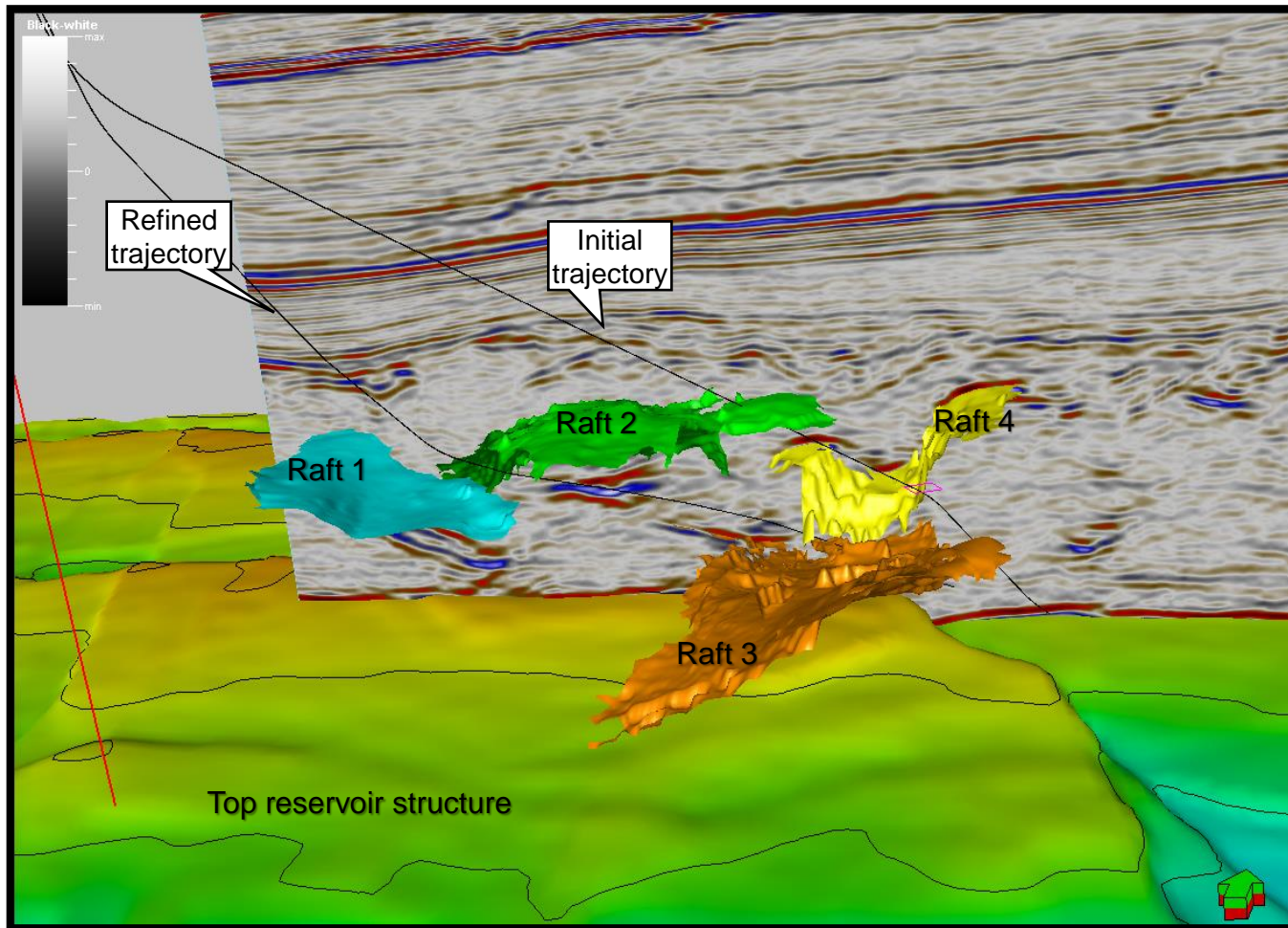
Zechstein deposition



Intra salt geobodies often contain high overpressures !!

Anticipating Drilling Hazards

Trajectory planning: dealing with targets & anti-targets



Avoiding *Geo-Hazards* requires careful trajectory planning

GDE DB helps in risk assessment!

Conclusions

1. A wide range of sub-surface geohazards do exist.
2. Geo Drilling Events Database uses classification system for *drilling observations* and *geological interpretations* causing the GDE's.
3. ~ 1000 NL boreholes analyzed (and increasing) as part of Joint Industry Project.
4. Convenient user-interface based on webhosted Spotfire/GIS project.
5. GDE DB accessible for all operators in NL
6. GDE DB allows de-risking new well designs now.
7. GDE DB great starting point for further research.

Anticipating Drilling Hazards by Sharing Geo-Drilling Events Information Nationwide

by Guido Hoetz & Ivo Nijhuis

Questions?

Acknowledgments:

NOGEPa, TNO, Martin Ecclestone, Pieter Slabbekoorn, Maarten Middelburg, Gert Lammers, Mathijs Kuiper, Aalderik Baud, Peter Schilder, Ward Teertstra