



by Sharing

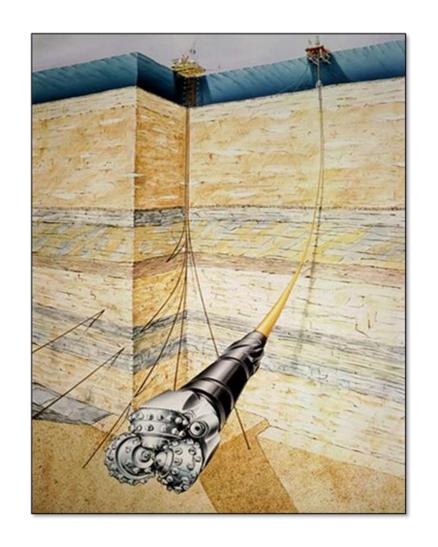
**Geo-Drilling Events Information Nationwide** 

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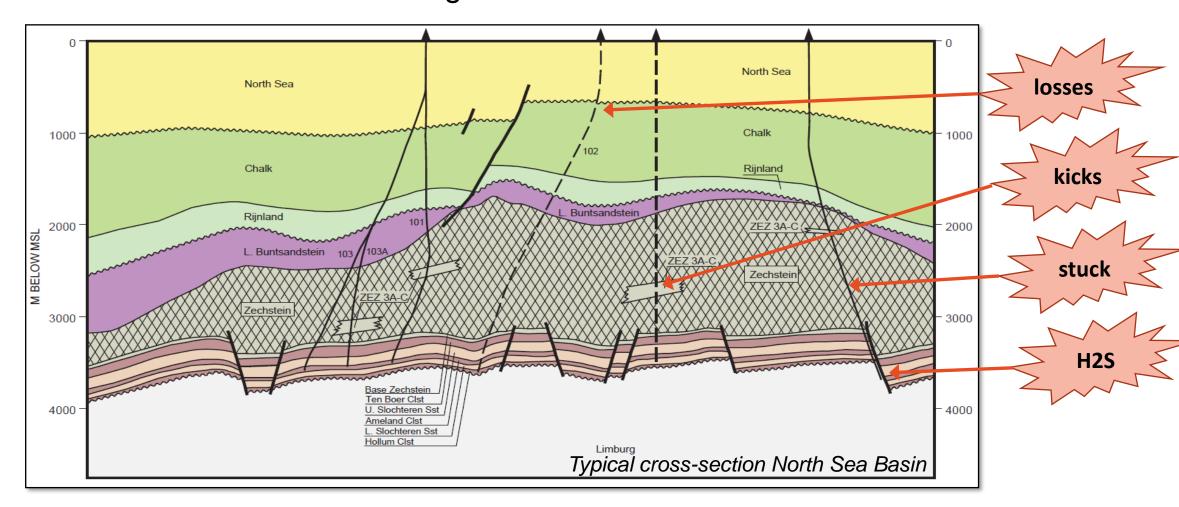
#### Content

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



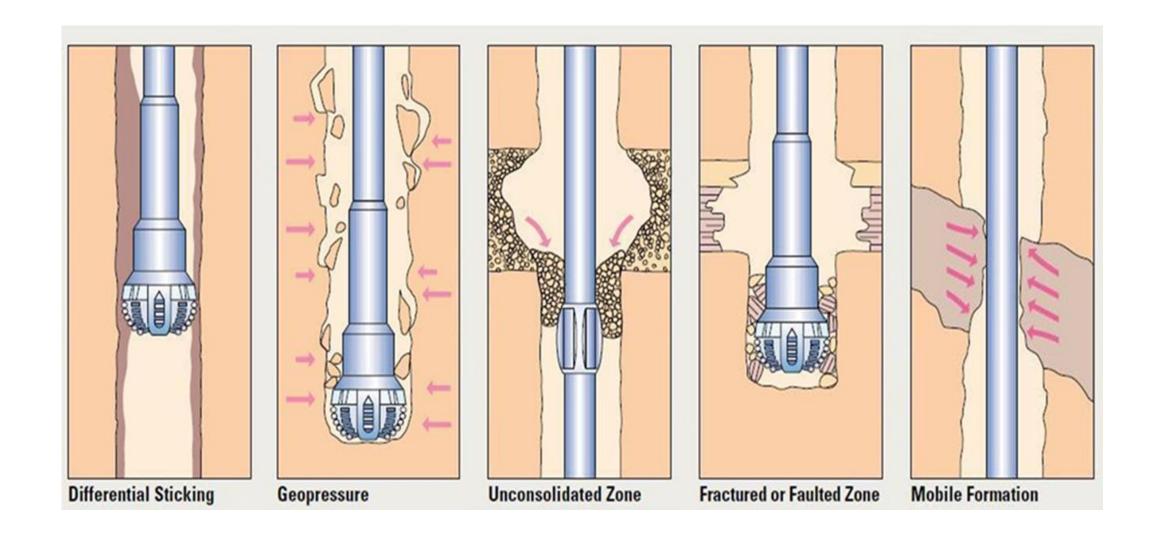


What are the geological considerations required to support **safe & effective** well design + well execution?





#### Drilling Hazards: Important cause of Non Productive Time

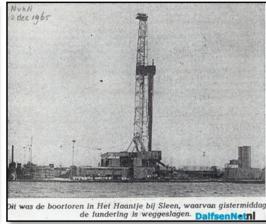




#### Hazard happens...

- 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









### Why compiling Geo Drilling Events systematically?

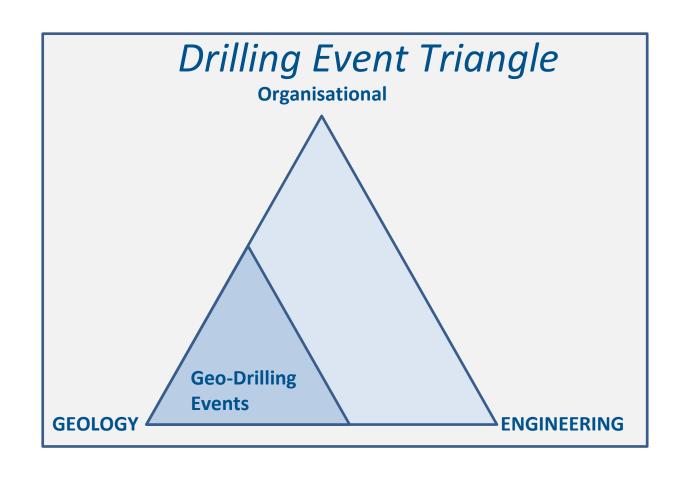
Improving well safety and well cost related to Geological Drilling hazards: reducing NPT via:

- Providing better <u>understanding</u> 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: Dutch state company investing in NL Oil/Gas and Geothermal is in excellent position to coordinate this initiative.





Drilling Events
can have one
-or morecauses!

- 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**

3. Geo-Drilling Hazards (*interpretations*)

4. Reference

Well Data	Well Metadata from	NLOGTNO						Geological Incident													6	enlogical Hazard				Reference	
			1		1	Surface coordinates	Surface coordinates		_ '	,			Incident START	Incident END date	Incident START	Incident START	Incident END	Incident END	Carrie and Articles	Stratigraphic unit of Incident - END	Max well deviation		_		,		_
\ \	Operator	Licence Name/Numbe	er Well category	Year of spud	Well trajectory	(UTM31-ED50)	(UTM31-ED50)		cident Code	Classification	Short description	Narrative Summary	date	if appropriate	depth	depth	depth if	depth if	Stratigraphic unit of Incident - START		between Incident	Ger		Geological Hazard			tation
1				_		,	,	2	_	_	_		_		_	_	appropriate	appropriate		start)	START-END depths	3				1	_
1 lin		*	▼ E/A/D ▼		vert/dev/hori	N Y			CODE	L/M/H *	1 line only	<u> </u>	dd/mm/yyyy *	ód/mm/γγγγ <sup>™</sup>	mAHRT *	mTVDSS *	mAHRT *	mTVDSS *	STRAT_UNIT_CL*	STRAT_UNIT_CL*	Degrees 💌			narrative summary		-	ocuments 💌
P11-A-02	-Canada (Dana	ME/EP/UM4020304	D	2006	deviated	5801250	523290		2		Bit Balling, reactive clays in N.Sea Group. Many wells in P11 and SNS suffer this problem.	Gumbo balling, poor penetration, packing off. Known hazard in N.Sea Group	14/09/06	16/09/06	596	575	611	593	NU		27		shales react with WBM			See Tab C	, and extract from mud summary
	veuity										Well TD is 200m shallow, target reservoir exposure reached															Acid et a	, are exercit non-new sentingly
P11-07	Petroleum	ME/EP/UM4020304	E	2011																							
P10-03	Veta Oil (Dana Petroleum)	E/EOG/MW/98086894	4 E	2001				N			Huge delay in moving the rig and starting due to weather. Otherwise no incidents																
P11-C-01	Dana Petroleum	ME/EP/UM4020304	D	2011				N			TRI-LATERAL WELL																
											Failure of MSIPC stage cementing equipment. Several remedial																
F02-A-03	Veba Oil (Dana	382/III/989/EMK	D	2001	+	_	-	N		-	squeeze jobs required. No geological based incidents.  Cemented in running string of 7"liner. Flash set cement. Back off						+			_	-	-					
l'anno	Petroleum)	100,00,000	'					"			required, 12.25" section redrilled. Not geological related, cement																
			+								quality																
F06-03	Petro-Canada (Dana Petroleum)	ME/EP/UM/02046774	1	2004				N			Chalk prospect well. No excessive geopressures encountered as in FOZ. Extra casing string set to cater for possible geopressures.																
P11-04	Amoco	E/EAM/92064098	E	1997				N			Several unplanned cores were taken. Oil discovery																
VO.sh.R1	GDE Suez	10	D	1999	deviated	5934057.2 5934057.2	551746.4 551746.4	v	4		salt water kick in the Zechstein	salt water kick in the Zechstein	10/10/99	14/10/99	3862		4210		ZESA			G 5	alt water kick			Drilling reports, geological repo	
VOsh,R3ct	GDE Supr	29	-	2013	deviated	5934057.2 5999364.9	551746.4 647989.2		16 16	-	abandoned because of problems during the 5" liner cementation. motor failure	abandoned because of problems during the 5" liner cementation. motor failure - At 2746 m. Allmost no penetration rate was noticed and we were not able to stall the motor,	26/07/07	29/07/07	2746		+		KNGL	_	-	_	tuck point			Drilling reports, geological repo Drilling reports, geological repo	
G16a-82	GDF Suez	G158	D	2011			*******	N				with 20 ton on the bit there was just 50 psi differential pressure therefore decision was made to pull out of	min.in.									·				Carporol Secusion (che	
						*******	447004				Land of the Control o	hole and change motor, bit and hydrastab.	40 004 003	22.04.02	****		200		du .	1000							
G16a-R4	GDF Suez	6160	n D	2012	deviated deviated	5999363 5999363	647991 647991	v v	10		few washouts, poor Real Time GR readings a few washouts in drill string @ bit depth: 2278m.	few washouts in drill string @ bit depth: 2278m, 2334m, 3029m, 2452m and 2692m poor Real Time GR readings in interval 2885m to 3221m MD - what determined to re-log hole in some	19/01/12 26/01/12	22/01/12 27/01/12	2278 2885		2692 3221		KNGL	RNSO		w				Drilling reports, geological repo Drilling reports, geological repo	
G162-84	GDF Suez	G168	J 0	2012				, T			2334m, 3029m, 2452m and 2692m, poor Real Time GR readings in	intervals.		.,,,,												.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
											interval 2885m to 3221m MD - what determined to re-log hole in some intervals.																
F3-8109	GDF Suez		D	2011	deviated	6079978.6	608915.07	Y	4		MU - what determined to re-log hole in some intervals.  drill string stuck.	High gas readings and well flowing was observed at 3859 m. Well was shut in and	29/01/12		3734				SLCU		_	G				Drilling reports, geological repo	rt
13-0109	GUF SIEZ	l <sup>2</sup>	"	2011				'				pressures monitored. Mud weight increased from 1.08 to 1.27 sg.															
					deviated	6079978.6	608915.07		1			Drilling couldn't be resumed because of drill string stuck. Worked and jarred to free it and reduce MW to 1.05 sg. After a few days of unsuccessful attempts, it was shot off and remained 104 m of BHA downhole.	14/02/12		3859				SLCU			D				Drilling reports, geological repo	rt
K12-55T1	Planid	K12	D	1981	deviated	5914080.4	547075.7	v	3		drillpipe became stuck (differential sticking)	Unexpected lamprophyre section the Basal Zechstein was found close to the expected depth.	30/09/81	04/10/81	3030		3288		ZESA			R L	Jnexpected lamprophyre			Drilling reports, geological repo	rt
1000			*					'			It was impossible to work the pipeline free and it was decided to												section				
					deviated	5914080.4	547075.7		3		abandon the well.	Unexpected lamprophyre section the Basal Zechstein was found close to the expected depth.	30/09/81	04/10/81	3030		3288		ZESA			4	Jnexpected lamprophyre			Drilling reports, geological repo	d
														.,,,,,									section				
					deviated	5914080.4	547075.7		1			In total 561 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.							ROCLT			D				Drilling reports, geological repo	rt
E17a-A4	GDF Suez	E17	D	2012	deviated	5994701.2	523651.9		1	<b>+</b>	mud motor stalled and lost after drilling to 4270mMD	Impossible to work the pipeline ree and it was decided to addition the well.  Mud motor stalled and lost after drilling to 4270mMD. Several unsuccessfull attempts to free the drill string	02/04/12	12/04/12	4270		1		ROCL	_	_	F	oor hole stability because of ab	ndent natural fractures		Final Geological report (June 2)	012)
E178-W4	GOF SUEZ	E1/	, u	2012				'			-	ended with setting a cement kick off plug between 4261m to 3979m and drilling a side track from 4100m.															,
L15b-A105	GDF Suez	L15b	D	2010	deviated	5910703.7	622010.8	Y	1		the string became stuck.	Due to already high torque during drilling caused by cutting build up, which increased when drilling in the chalk to set the 13 3/8" casing shoe, the string became stuck.	01/03/10	12/03/10	1600		2000					2	poor hole stability due to proble	s in the Tertiary		Final well report	
110/014	Discid	110	n	1986	deviated	5928103.4	584285.4	v	9		collapsed casing	collapsed casing due to sait flow re-entry	18/03/86		3006				ZESA			S s	alt flow re-entry			Formation evaluation data	
¥13.68	CDE Coar	¥17	n	2017	deviated deviated	5912451.8 5912451.8	565470.5 565470.5	v	3		Low drilling rate in the Zechstein, stuck pipe	20 days due to the occurrence of almost 200 m of high strength igneous (lamprophyric) rock in the Zechstein	28/05/07		3768		2770		ZESA			R I	amprophyre section			Drilling reports, geological repo	
WIT-1	NAM	Drenthe	E	1994	deviated vertical	5912451.8 5875248	565470.5 737579	Y	?	<u> </u>	Soft formation, unable to achieve KO	Stuck pipe @ 3777 m, @ 3778 Soft formation, unable to achieve KID	28/05/07 20/11/94	21/11/94	3777 668		3778 668	<del>                                     </del>	ZESA NU	NU	_	2 5	quizzing salt			Drilling reports, geological repo	п
WIT-1	NAM	Drenthe			vertical	5875248	737579	Y	3		Abrasive fm.	Abrasive formation	30/11/94	01/12/94	2130		2130		RNSOB	RBSHR		A					
WIT-1 WIT-1	NAM	Drenthe Drenthe			vertical	5875248	737579	N 2	6		drilling too deep, section TD missed While RIH 13 3/8" csng stuck in CKGR	Drilling too deep, section TD missed  While RiH 13 3/8" cong stuck in CKGR	04/12/94 06/12/94	04/12/94	2498		2498		ZEZ4H CXGR	ZEZ4H CKGR		2					
MOL-2	NAM	Andel II	E	1986	vertical vertical	5875248 5747667	737579 625291	Ϋ́	1	<del>                                     </del>	While RH 13 3/8" csng stuck in CKGK directional problems and plugged nozzles	While RH 13 3/8" csng stuck in CXGR Directional problems, plugged nozzles (12.25 hole)	9	9 2	1387		<del>                                     </del>		AT	AT	?	5					
MOL-2	NAM	Andel II			vertical	5747667	625291	Y	1		heavy reaming	Heavy rearning (12.25 hole)							AT	AT	?	S					
MOL-2 MOL-2	NAM NAM	Andel II Andel II			vertical	5747657	625291	Y	1		Hole problems, stuck pipe Slow progress	After havy reaming the drill stringstring became stuck > sidetrack (12.25 hole) Sinus moraness	02/03/86	12/03/86	2230		2230		TA.	TA		S					
MOL-2	NAM	Andel II			- British								24/03/86	07/04/86	2710		2710		, n			Š					
MOL-2	NAM	Andel II	<b>D</b>	-+-	4														AT	RNO		s					
MOL-2 SSM-4	NAM NAM	Andel II Groningen	⊢ Di	ata	tyk	es:							25/12/07	28/12/07	1224		1224	-	RB CXGR	RB CKGR	$\vdash$	A S					
LWZ-3	NAM	Groningen			, ,								10/09/07	19/09/07	1201		1201		NLFFY	NLFFY		S					
LWZ-3A COV-58	NAM NAM	Groningen Schoonebeek	_										15/10/07 20/06/07	15/10/07 21/06/07	3889		3889 3170		2E22H	2522H	$\Box$	6					
AME-205	NAM	TER	1	(	200	Oriz	we	11 4	1+2				20/06/07	21/06/07	3170 1249		3170 1249		ZEZ3C NLFFY	ZEZ3C NLFFY	<del>                                     </del>	S					
AME-205	NAM	TER	I.	(	שכו	וכוונ	, we	:II U	ald				22/05/07	23/05/07	1979		1979		CKGR	CKGR		A					
AME-205 BRAK-01	NAM NAM	TER Andol III	-									and the state	08/06/07 21/05/92	07/08/07	2919	100	2919	/10	ZESA	ZESA	<b>⊢</b> ,	G	hadina dan arandan	a materalish arroad by worker d		1003 03 03 BBAK 1 Davidston	of operations 11-05 to 02-07 odf
BRAK-01 BRAK-01	NAM	Andel-III Andel-III	7	(	200	Dr	illin	G EV	OD:	tc / 1	facts)	ensea in place. ented in place.	21/05/92	22/05/92 22/05/92	325 325	325	418 418	418 418	NUOT		1			e potentially caused by washouts e potentially caused by washouts			of operations 11-05 to 02-07.pdf of operations 11-05 to 02-07.pdf
			<b>L</b> .	(	コモし	וטיי	1111113	≍ ∟v	CII	LD [/	uctsi																



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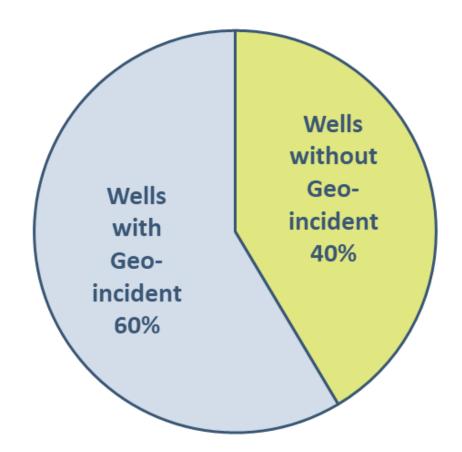
#### Results To Date\*

•	Number	of	borek	noles	anal	yzed	1000
---	--------	----	-------	-------	------	------	------

Boreholes with Geo-Events 600

Number of Geo-Events 1170

Wells with Insufficient data

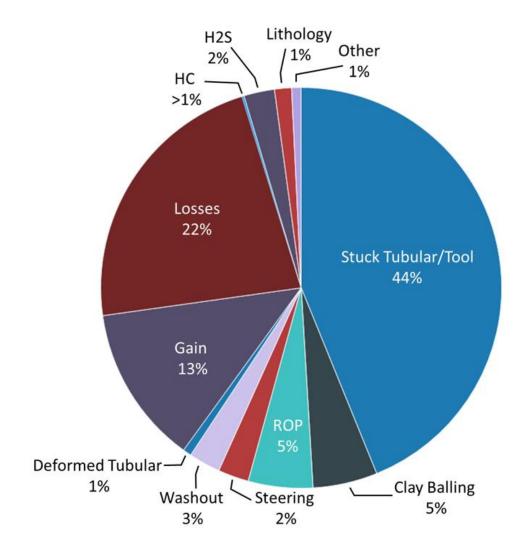


<sup>\*</sup>statistics as per Sep 2019



### **Drilling Events = facts**

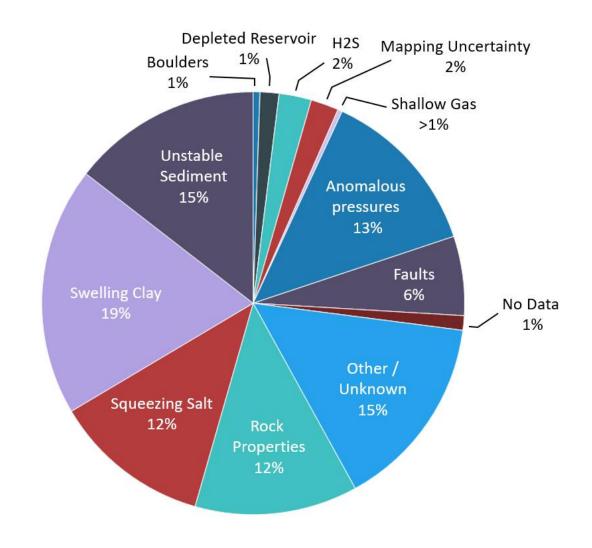
	1	Stuck Tubul	ar/Tool	514
	2	Clay Balling		61
	3	ROP	61	
S	4	Gain	150	
/pe	5	Losses	263	
<b>Event types</b>	6	Lithology	16	
en	7	НС		2
EV	8	H2S	29	
	9	Deformed T	8	
	10	Washout	30	
	11	29		
	12	Other		9
			Total events	1172





### **Geo hazards = geo interpretation**

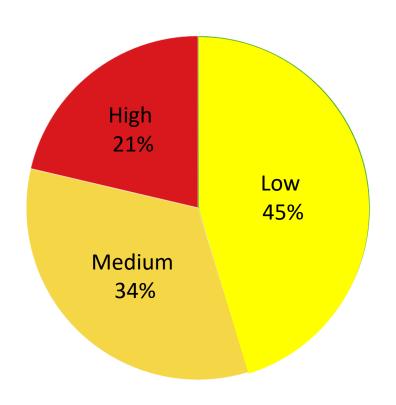
	Faults		71		
	Swelling C	Clay	223		
ks	Squeezing	Salt	141		
rocks	Unstable S	Sediment	170		
ا ا	Boulders		6		
	Rock Prop	erties	146		
	Depleted	Reservoir	17		
fluids	Shallow G	as	4		
lui	Anomalou	ıs Pressures	152		
Į	H2S		29		
er.	Mapping	Uncertainty	25		
ther	Other / U	nknown	175		
o	No Data		13		
		Total	1172		

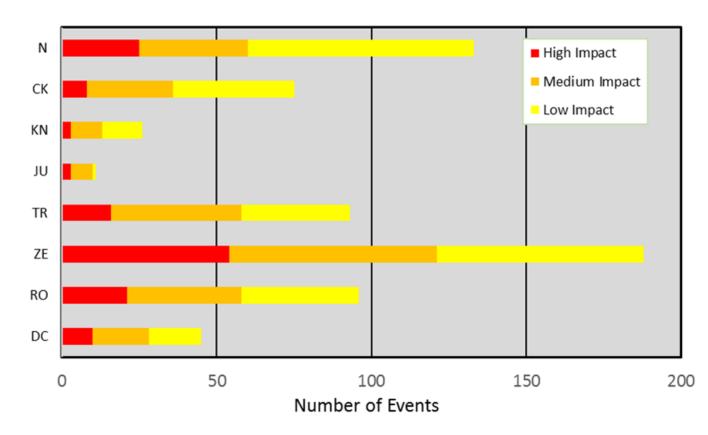


classification is key!



### **Incident severity**





Severity of incident:

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

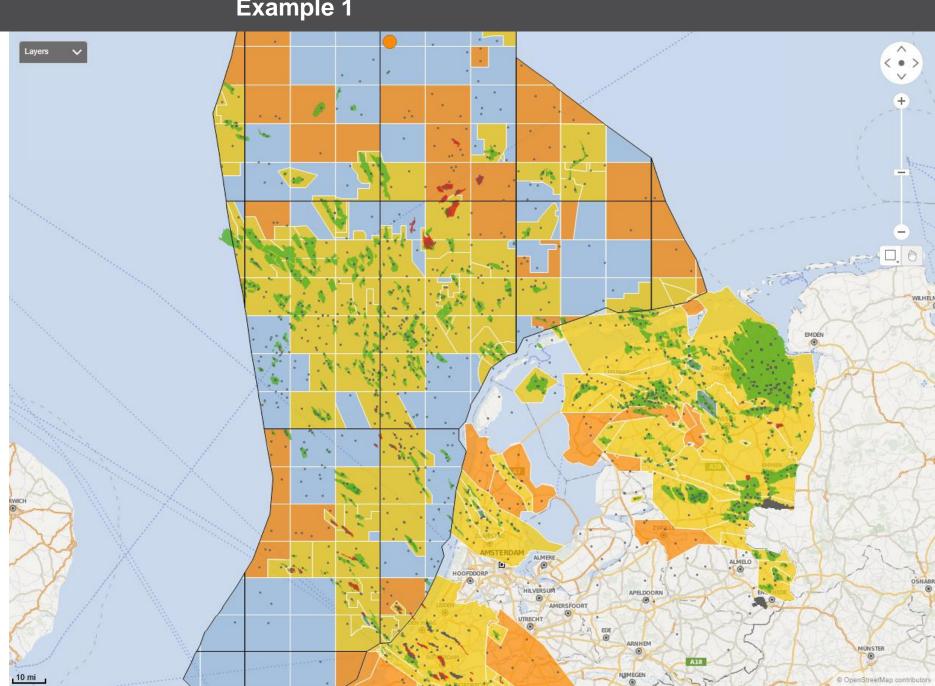
classification is key!

**Example 1** 

GDE DB mapview:

licences

Multiple information layers can be selected

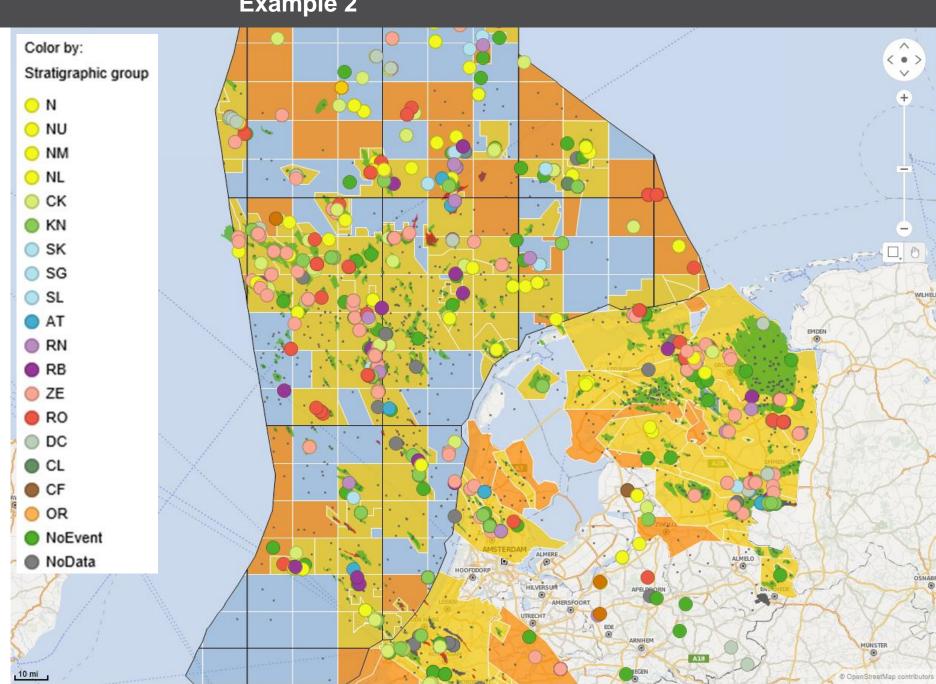


#### Example 2

#### GDE DB mapview:

- Licences
- **Events**

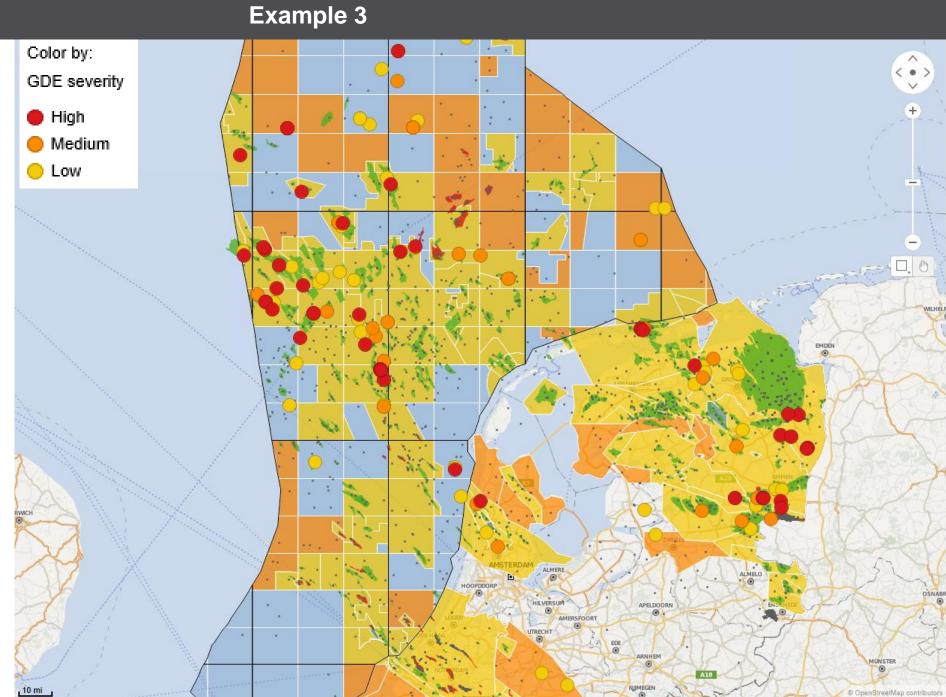
**Events** colorcoded by stratigraphy



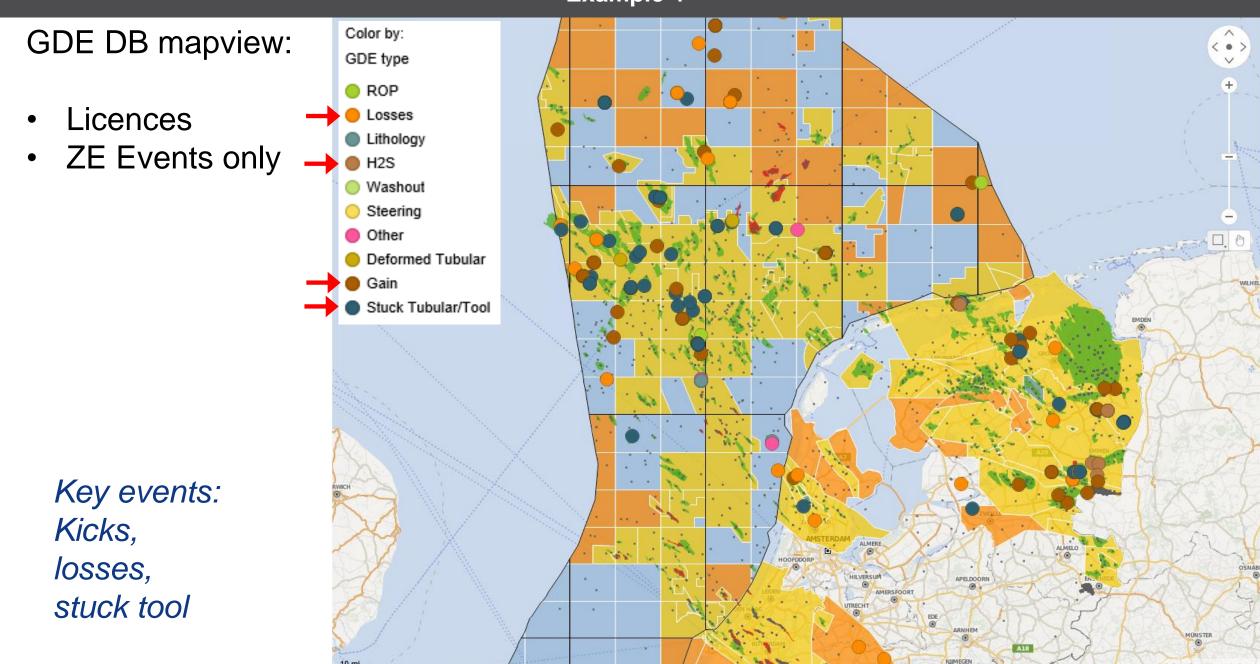
#### GDE DB mapview:

- Licences
- ZE Events only

**Events** colorcoded by severity



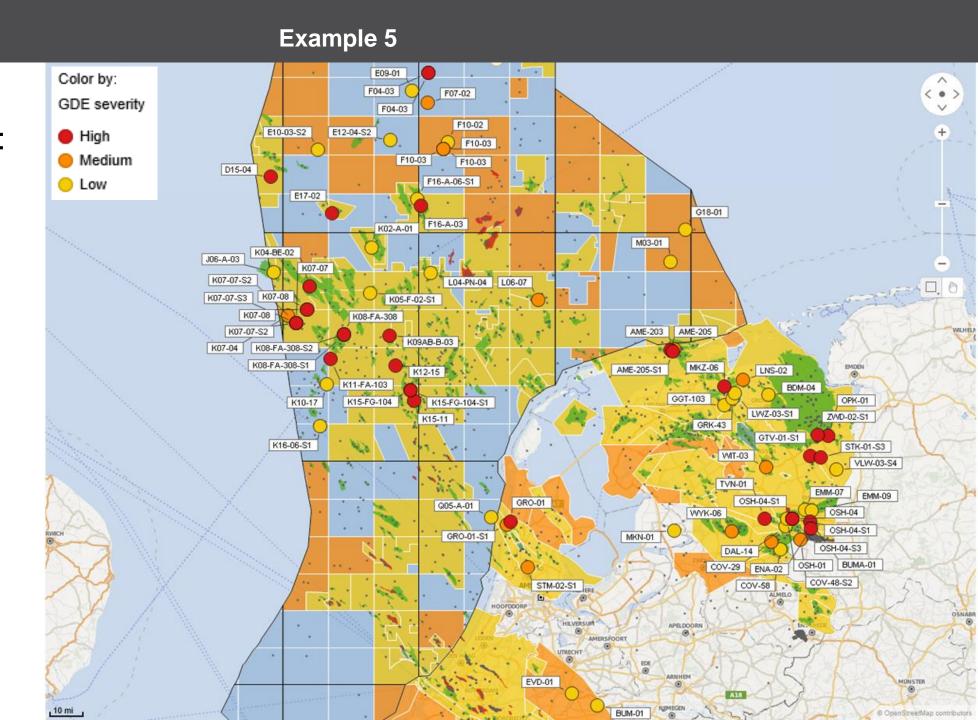
Example 4



#### GDE DB mapview:

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

83 cases

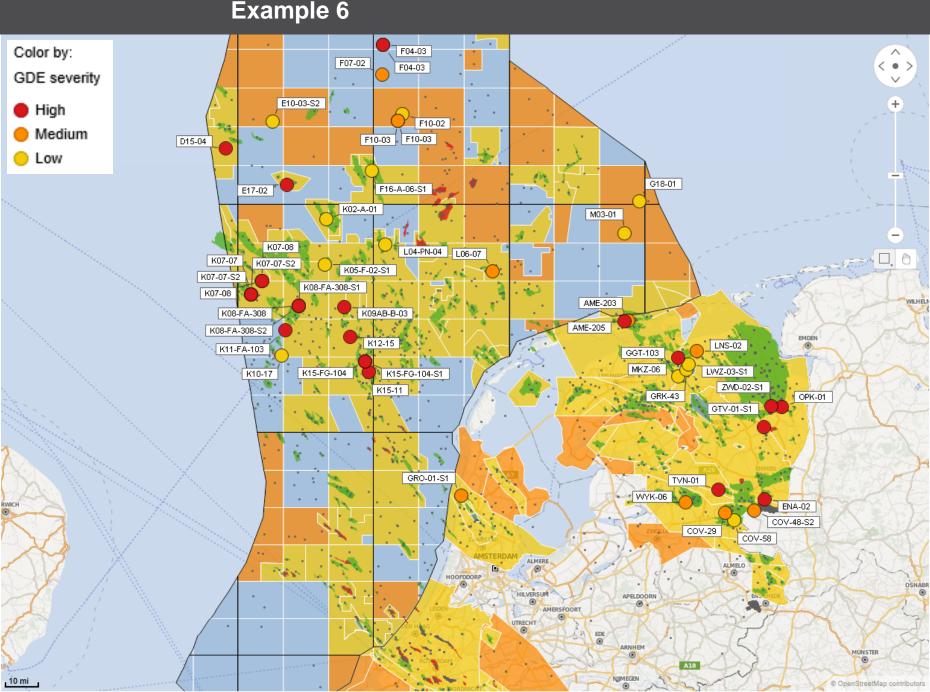


#### Example 6

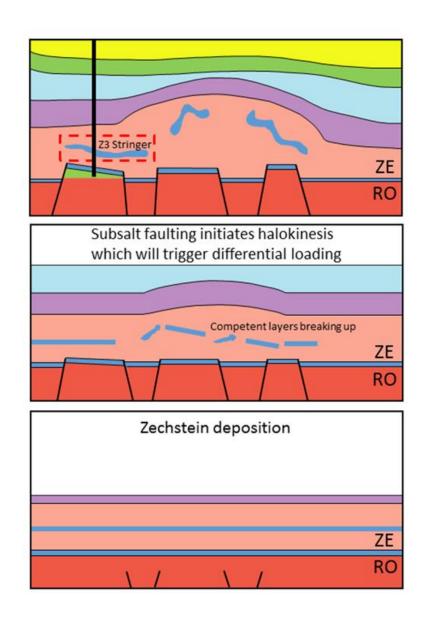
#### GDE DB mapview:

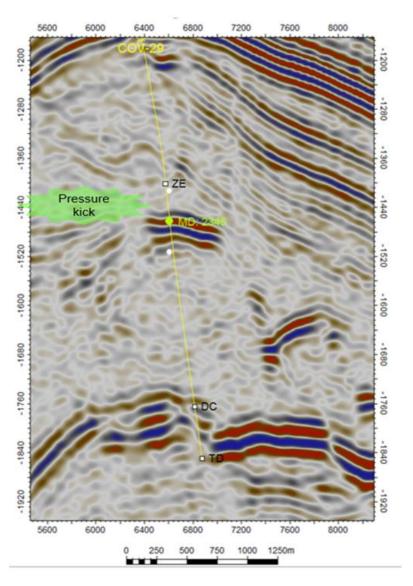
- Licences
- ZE Events only
- Gains only

57 cases Zechstein kicks





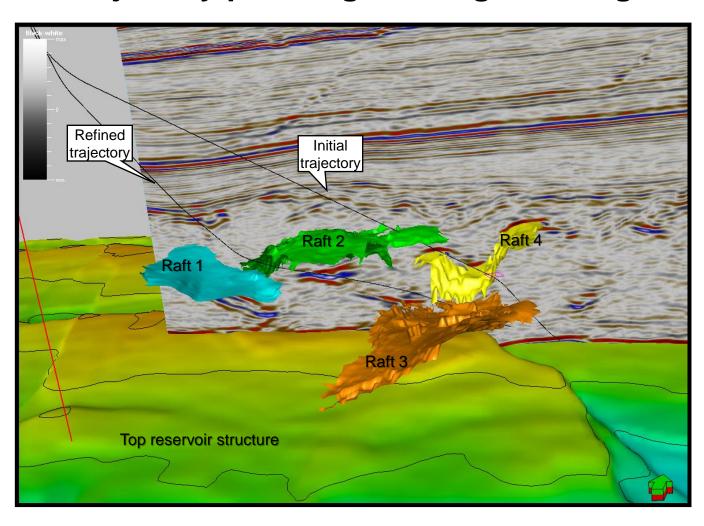




Intra salt geobodies often contain high overpressures!!



#### Trajectory planning: dealing with targets & anti-targets



Avoiding Geo-Hazards requires careful trajectory planning

GDE DB helps in risk assessment!

#### Anticipating Drilling Hazards by Sharing Geo-Drilling Events Information Nationwide

### 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