

Shale Gas in NL

Potential impact on water quality

A trigger for research!

Dr. Niels Hartog (KWR/UU)

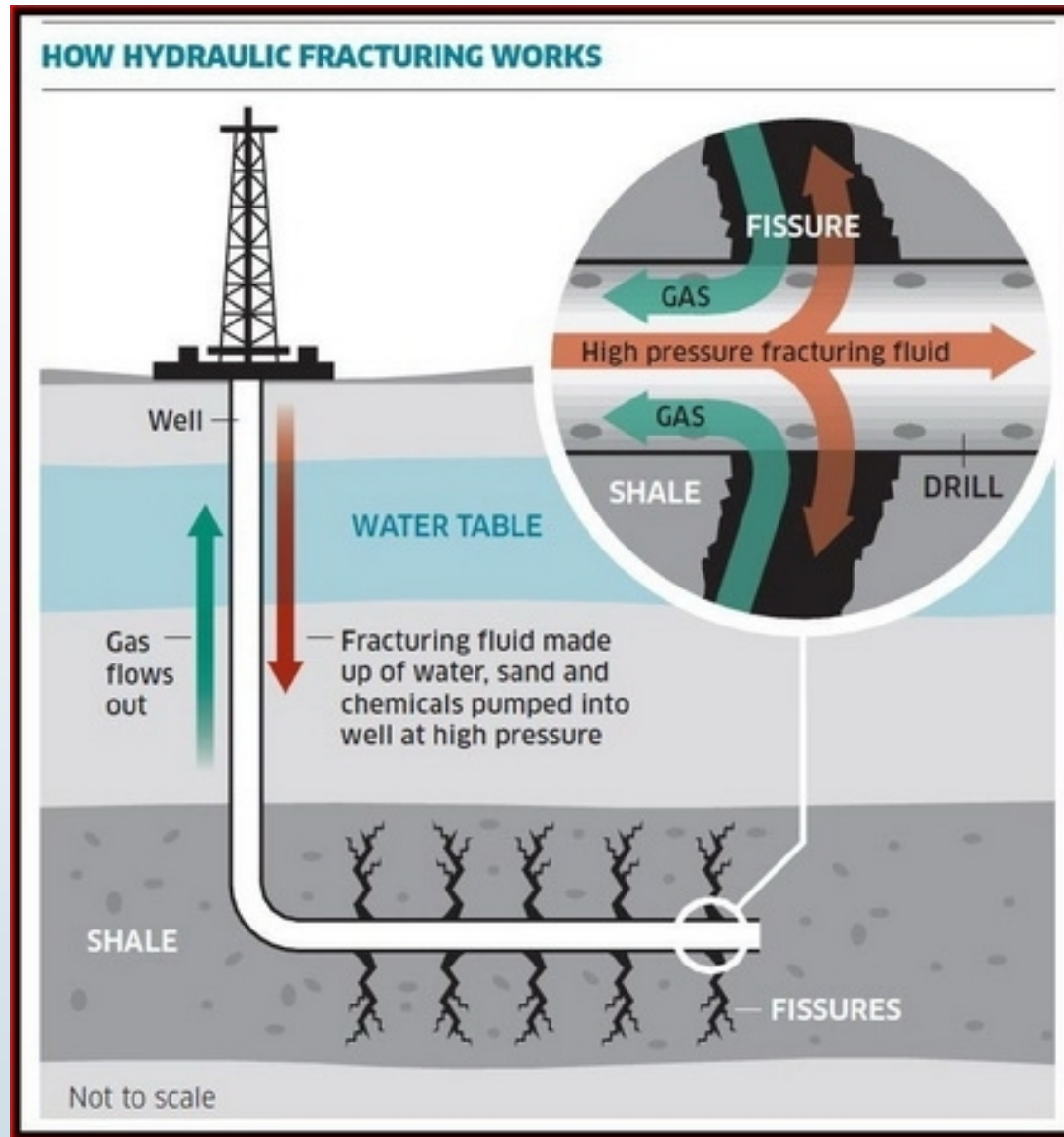
Dr. Gijsbert Cirkel (KWR)

Gilian Schout (KWR/UU)

Floor Verhoeven, MSc (KWR/UU)

and others!

1. Use of water resources
2. Stray gas (methane)
3. (Ground)water contamination
4. Induced seismicity
5.



Shale 2013 → today

niels.hartog@kwrwater.nl

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Shale Gas Drive, Wean de Row

ports



Pennsylvania landowners share the pain of low natural gas prices



LAURA LEGERE
Harrisburg Bureau

Employees work at a shale gas fracking site of Sinope

SEP 9, 2019

1:00 PM

ADVERTISEMENT

Rebecca Droke/Post-Gazette



ie Cuadrilla

ing site

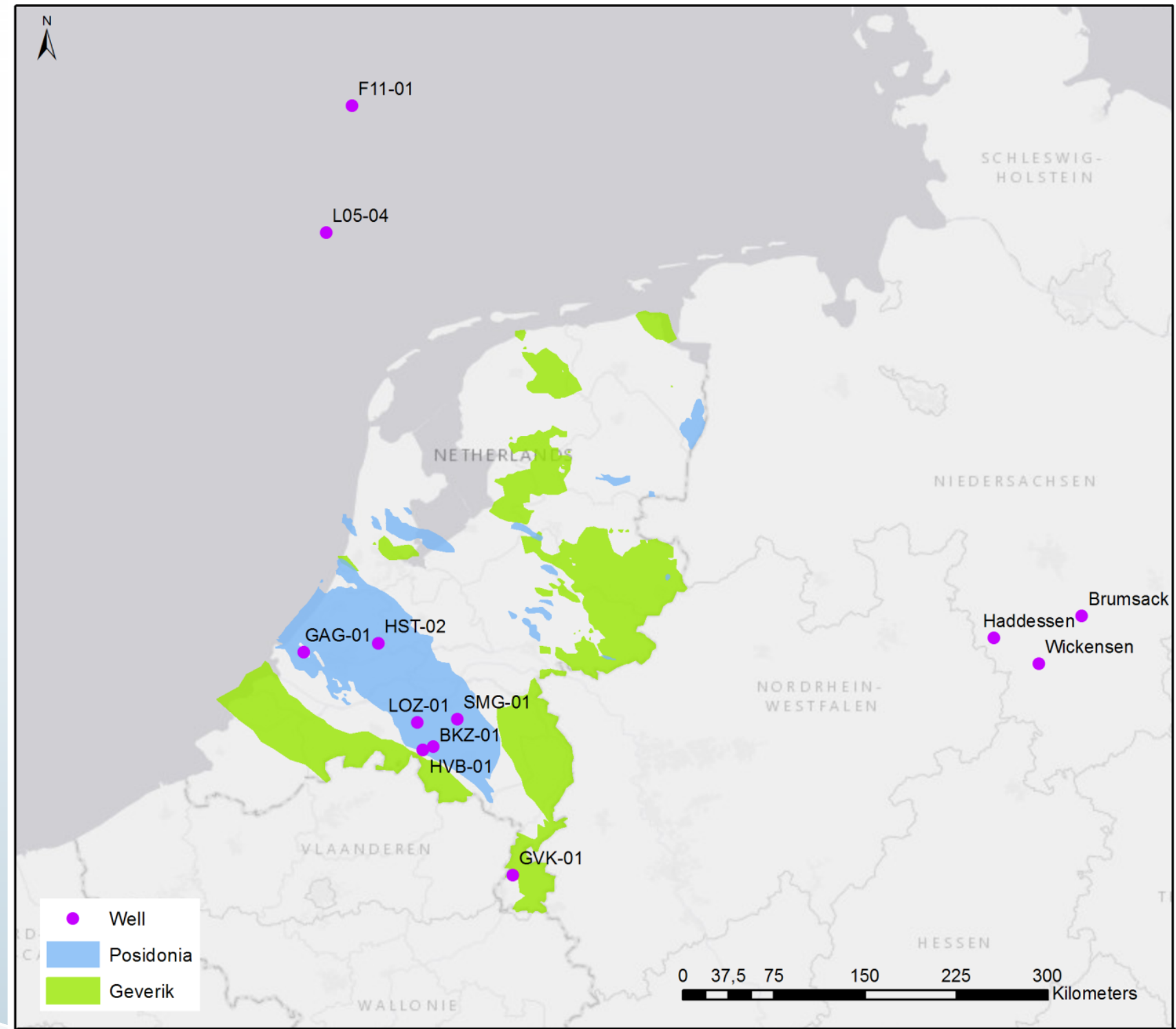
its site near Blackpool

Potential Shales and concessions

In the Netherlands

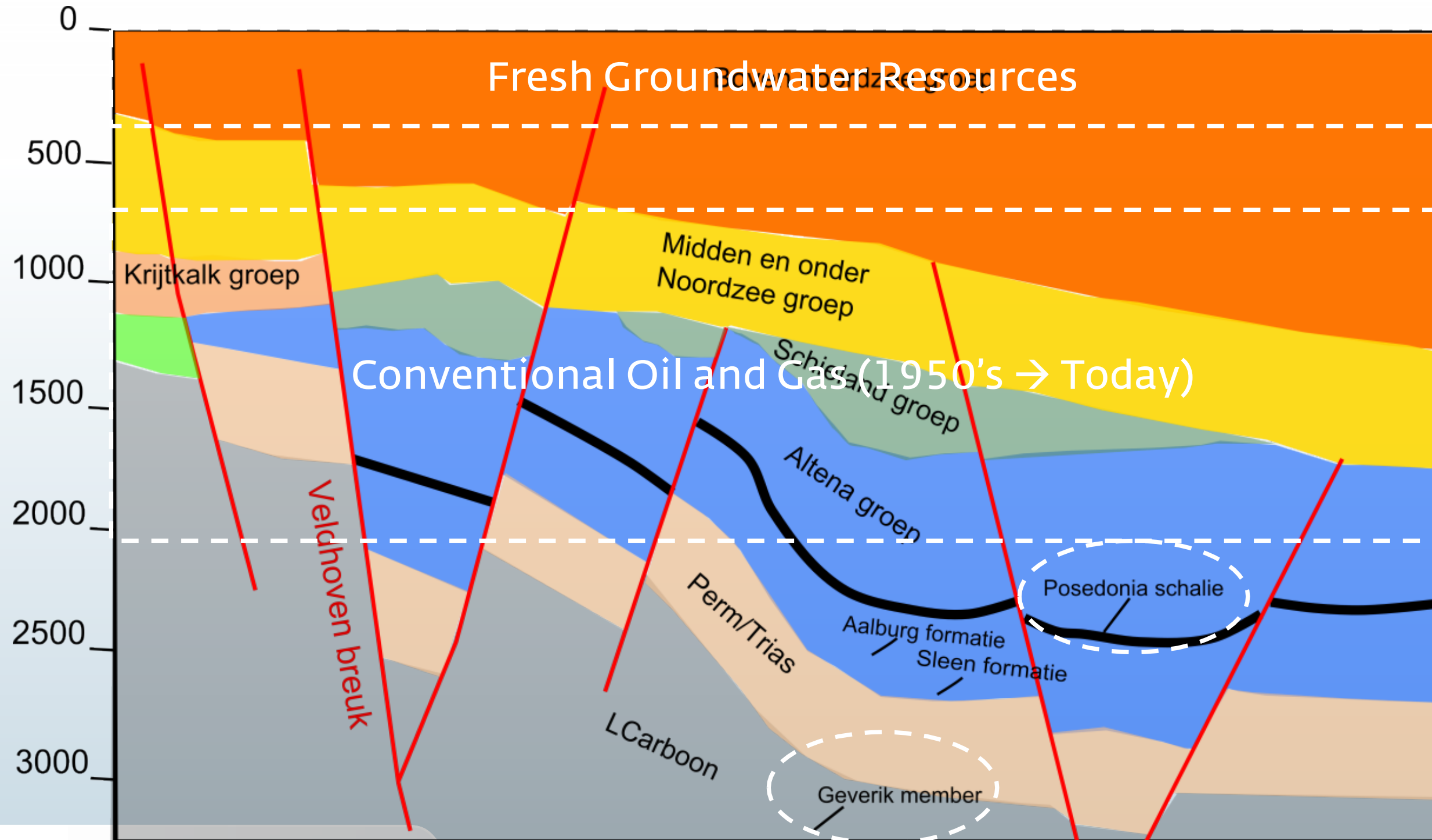
4

concessiegebieden

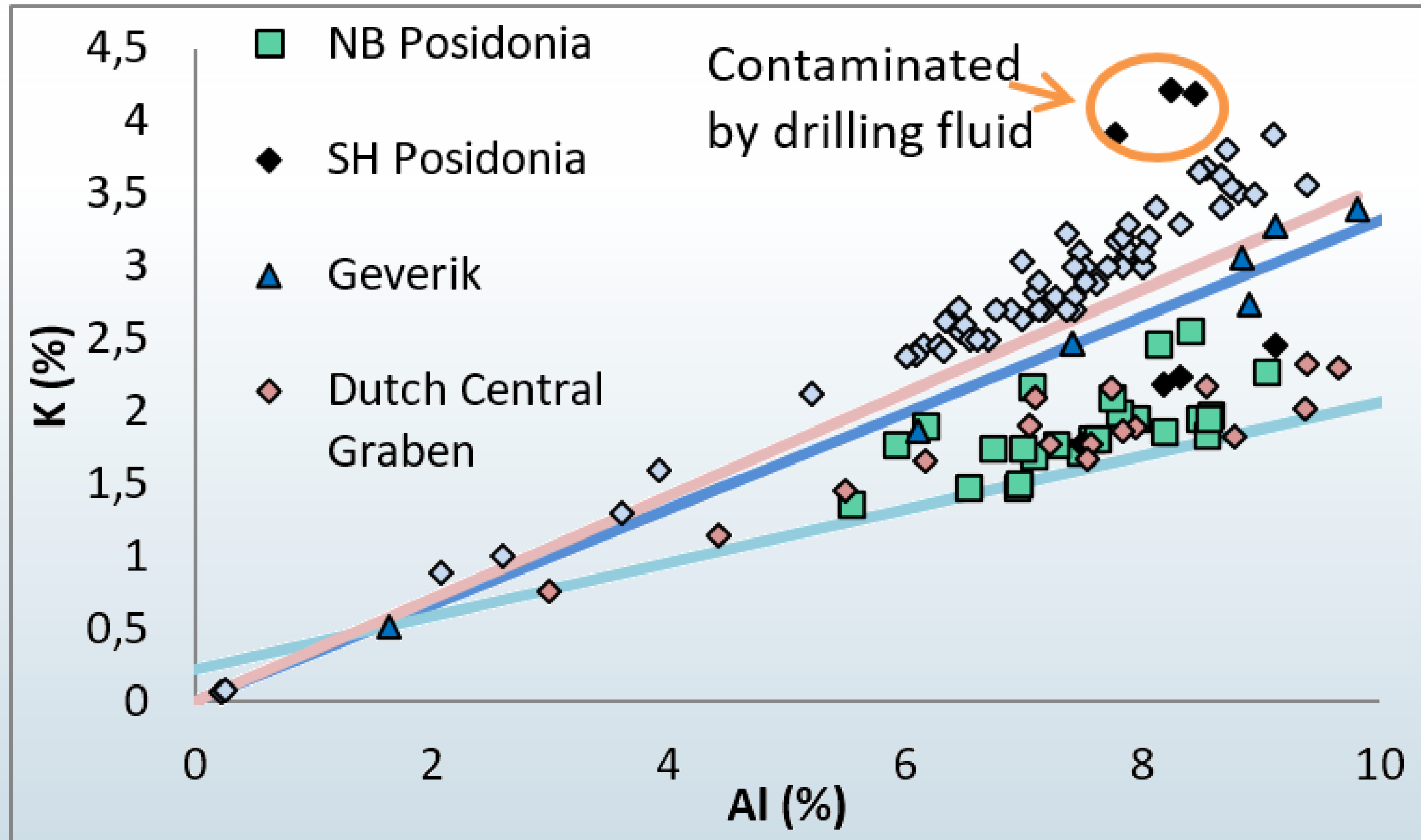


Complex geology Roer valley graben

5

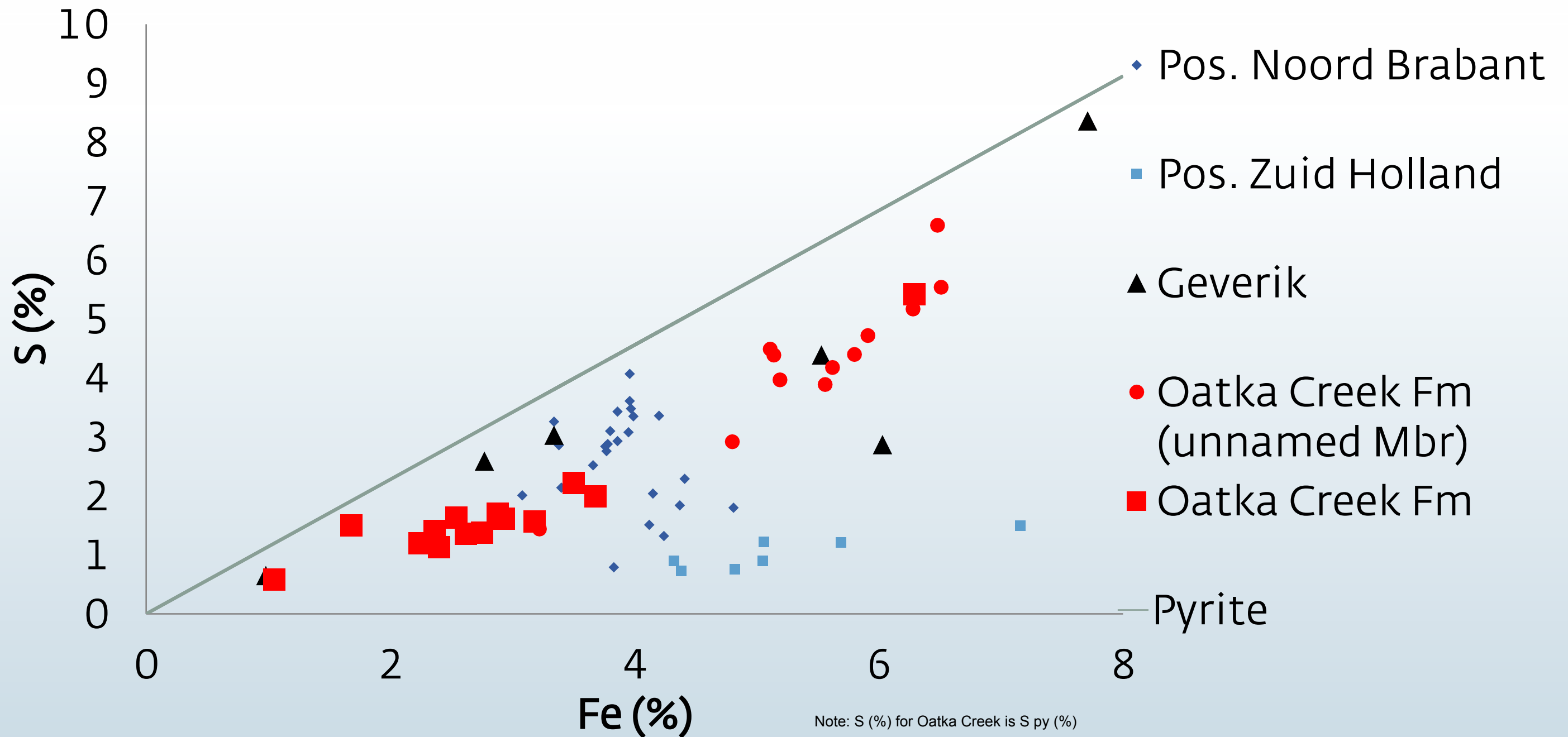


Shale composition

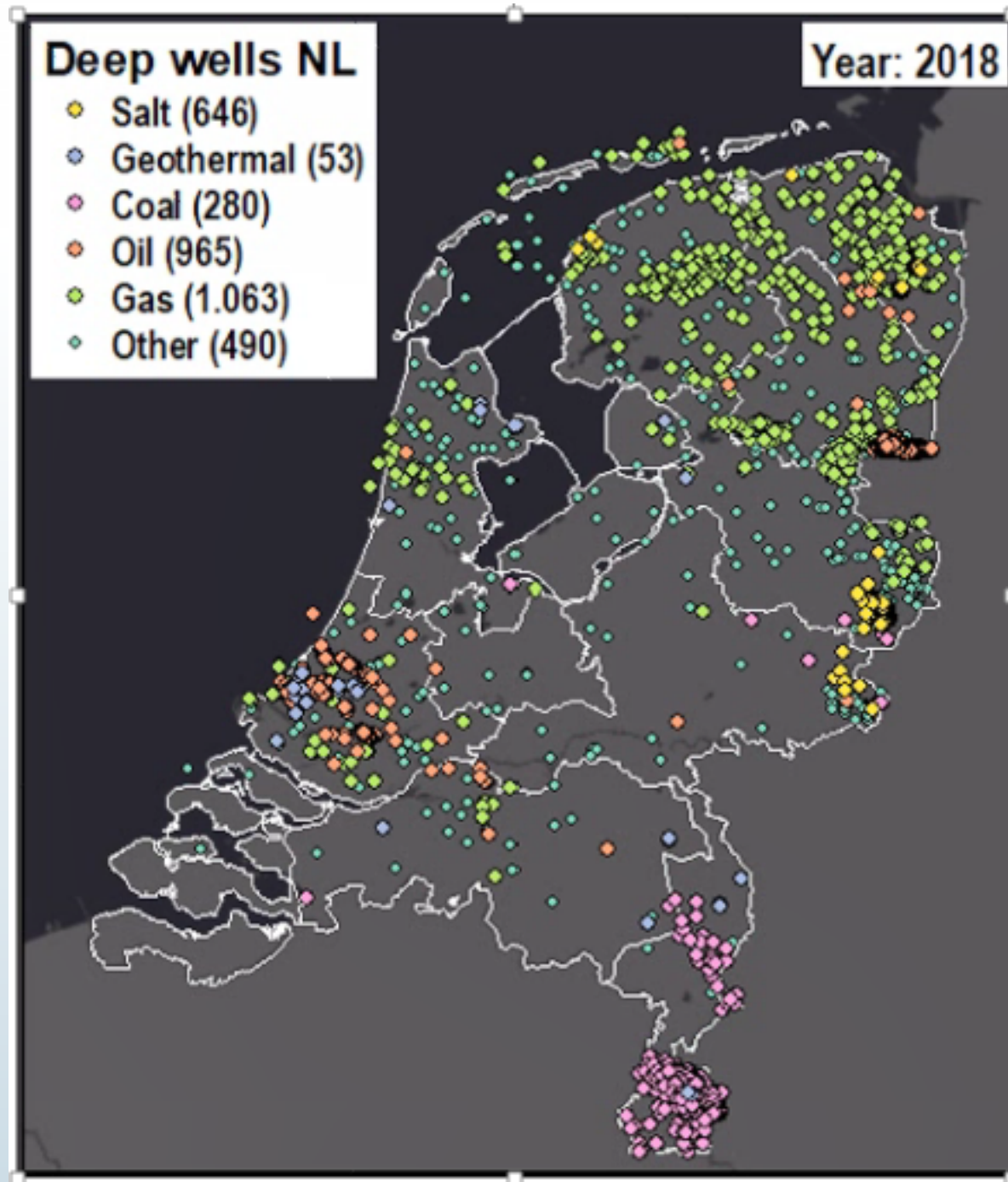


Fe-S comparison with Marcellus shale

Pyrite oxidation



Deep wells in NL (2018)



Gas	1063
Oil	965
Coal	280
Salt	646
Geothermal	55
Other	490
Total	3499

Subsurface blow-out (1955@Sleen)

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G Schout, N Hartog, SM Hassanizadeh, and J Griffioen, *The impact of an historic underground gas well blowout on the current methane chemistry in a shallow groundwater system*. PNAS, 2018. 115 (2): p. 296–301

- Still leaking methane!
- Impacting groundwater

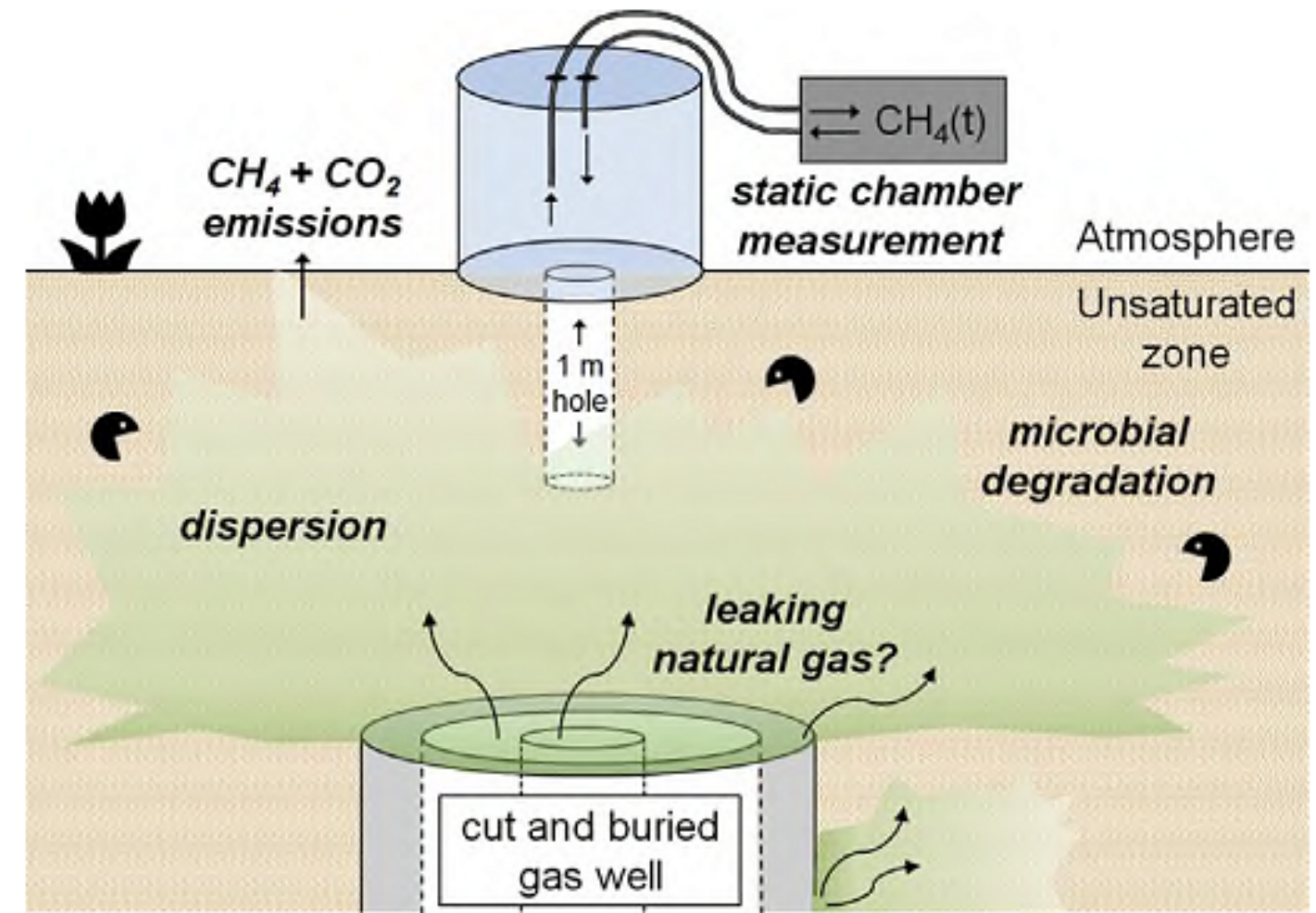
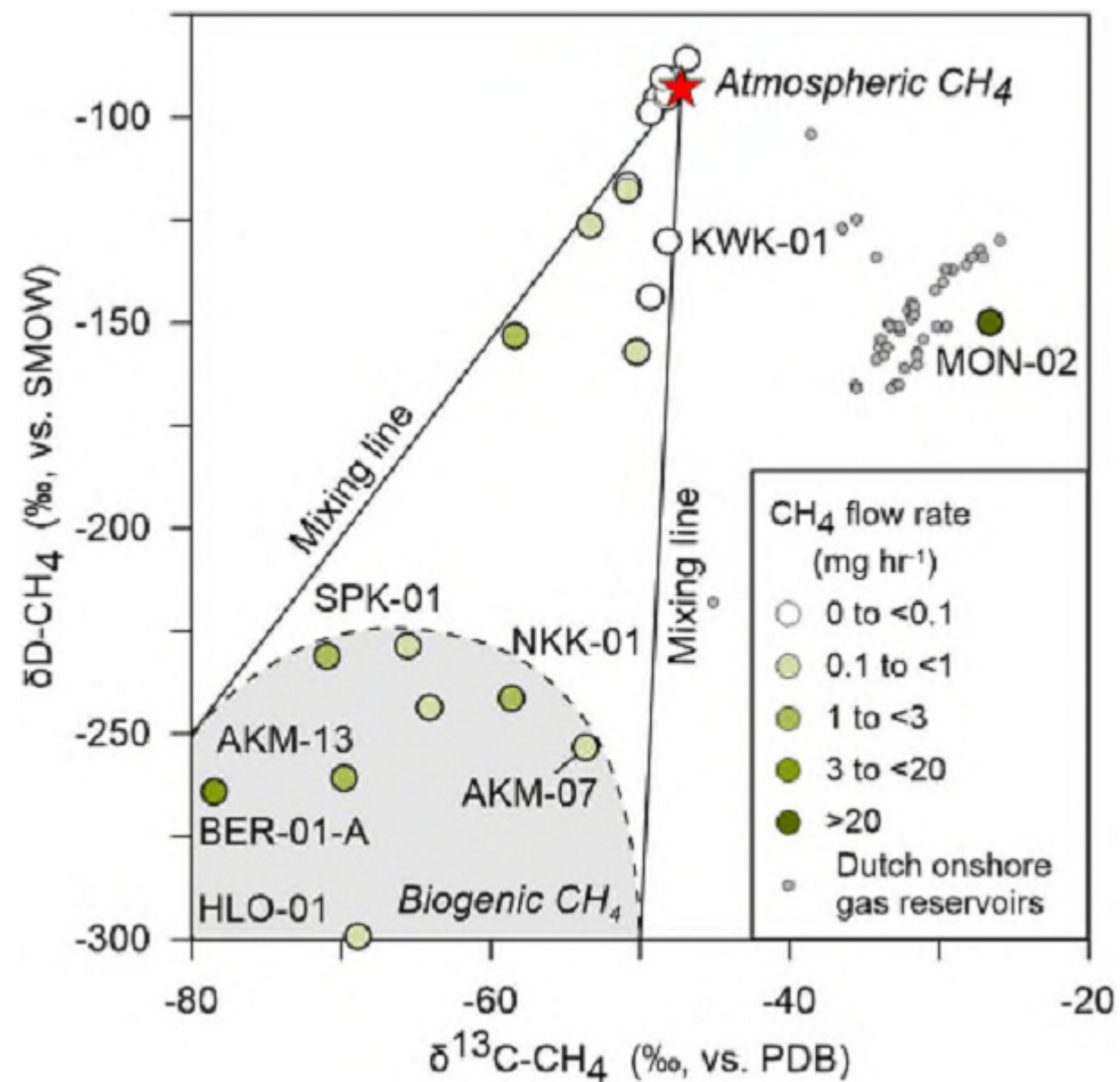


De monsterput in Sleen is over stroomde in 1955 met

Methane leakage (@Monster)

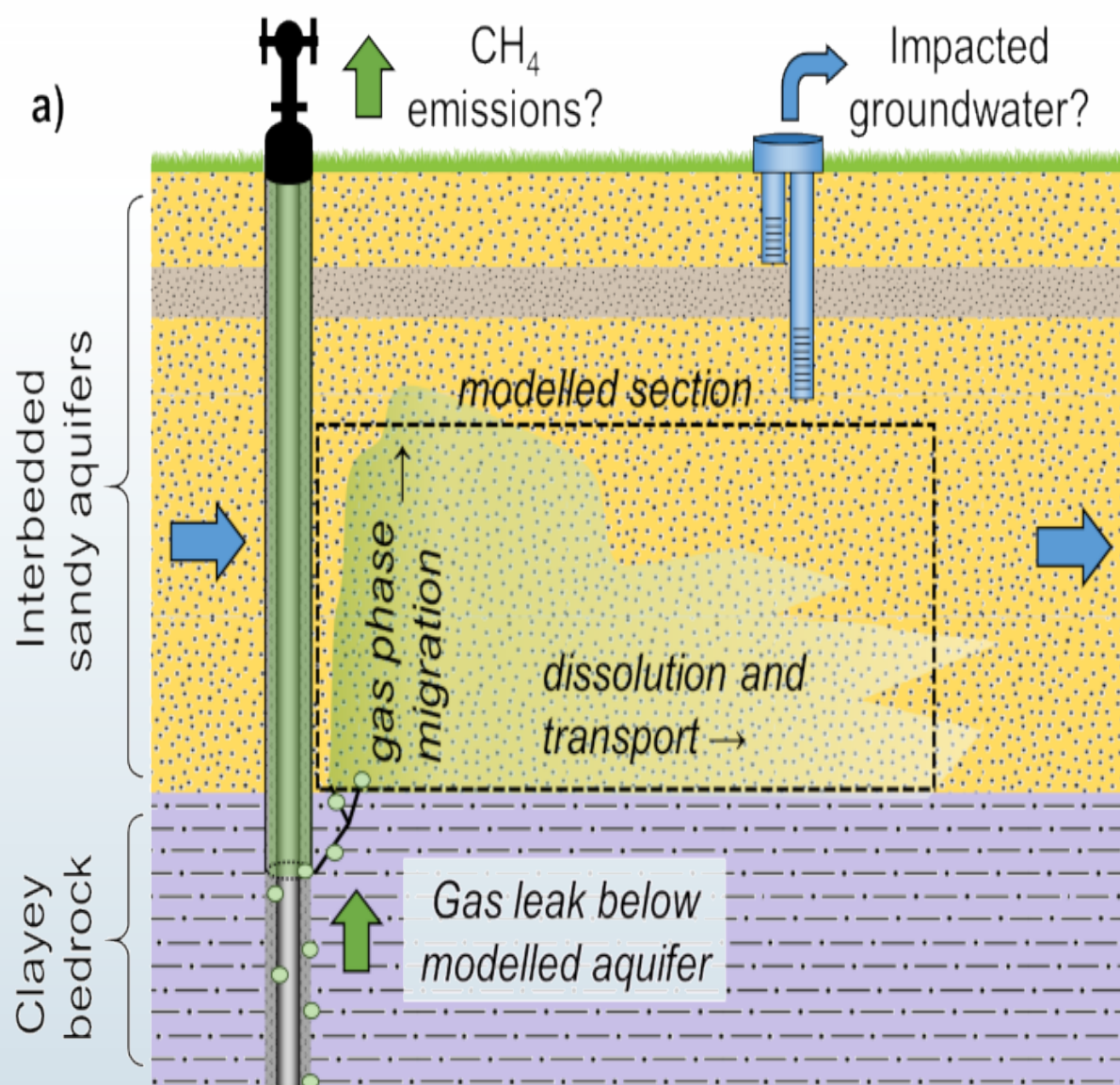
29 abandoned (cut-and-buried) oil/gas

10

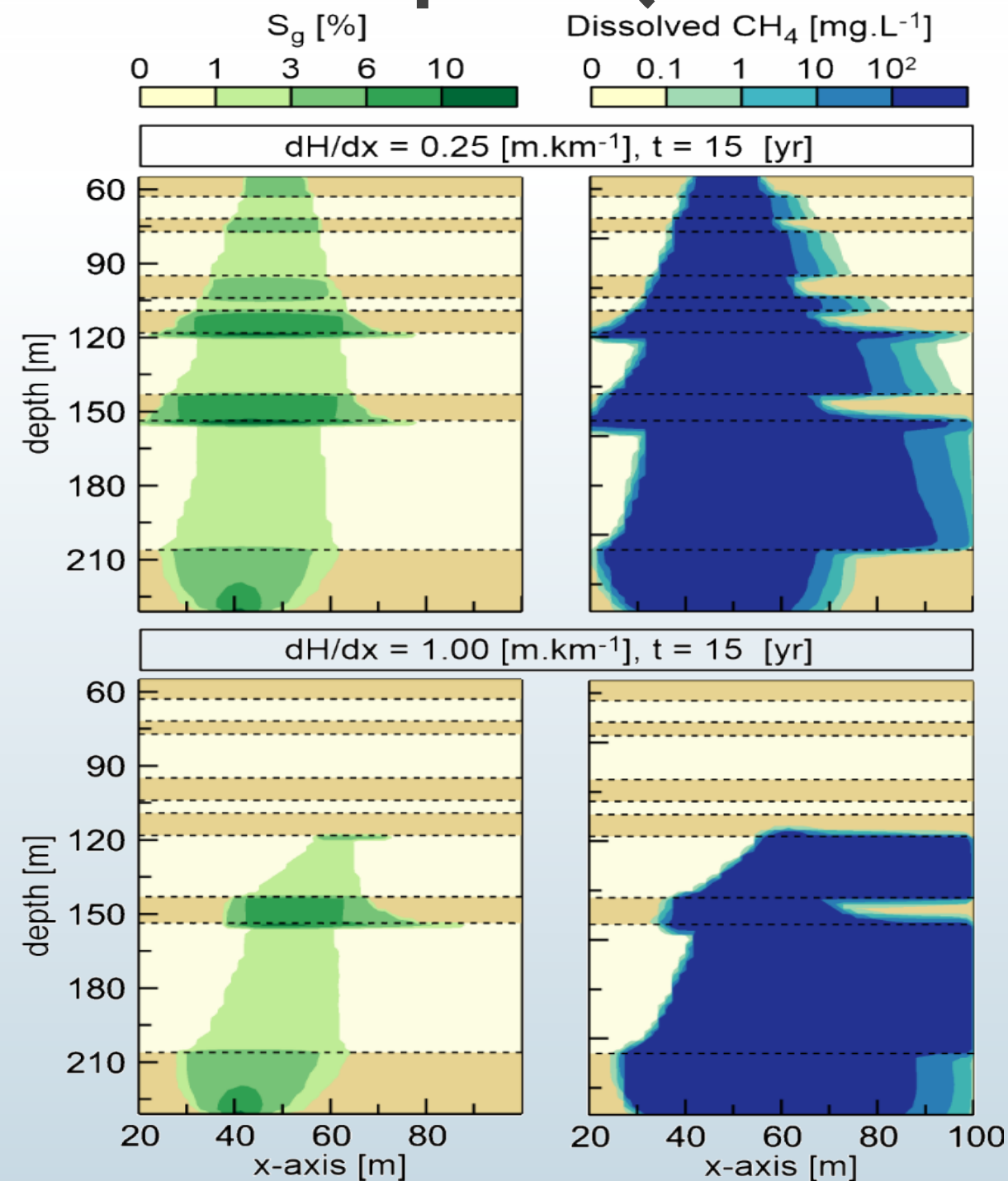


G Schout, J Griffioen, SM Hassanizadeh, G Cardon de Lichtbuer, and N Hartog, *Occurrence and fate of methane leakage from cut and buried abandoned gas wells in the Netherlands*. *Science of The Total Environment*, 2019. 659: p. 773-782

CH₄ retention: Impact of groundwater flow (numerical)



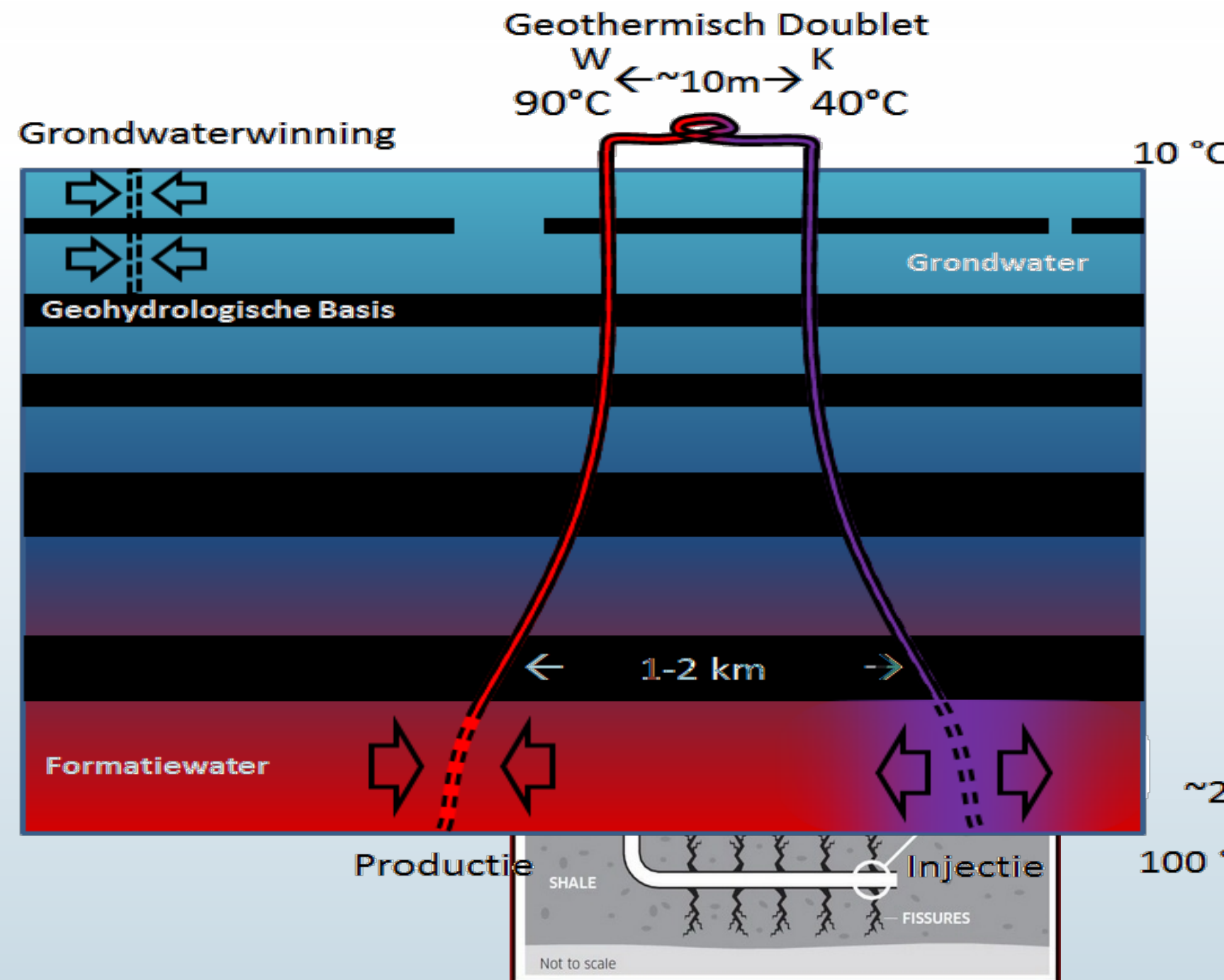
Schout et al (Submitted to JCH)



Quality of produced water

Shale gas → Geothermal

- Brackish to highly saline (>4-5 times seawater)
- Arsenic, heavy metals, lead, hydrocarbons, NORM
- Risks for groundwater contamination → Spills (transport, well corroding, leakage etc.)
- Challenge for water treatment plants with respect to composition and volume



No shale gas, but risks of sustainable energy

Subsurface: Geothermal and Aquifer Thermal Energy Storage (ATES)



Questions?

www.kwrwater.nl

KWR

Bridging Science to Practice

- **Van Loon, Arnaut** Session 6: Tue 10:50-12:35
Groundwater Protection: Concepts and Strategies For Securing Drinking Water Resources In A Changing and Uncertain World
- **Hartog. Niels** Session 2c: Tue 14:40-16:10
Prospective Shale Formations In The Netherlands: A Geochemical Assessment of Their Potential Impact On Water Quality
- **Van Dooren, Teun** Session 2b: Tue 16:40-18:10
Geogenic Arsenic Mobilisation To Groundwater From Glauconitic Sand Formations: Geologic Origin, Geochemical Controls and Possible Solutions For Drinking Water Production

Flowback/Produced water quality in NL?



Composition Dutch shale formations:
 Poseidonia (Brabant + Zuid-Holland)
 Geverik (Limburg)

Floor Verhoeven

Differences in Dutch Posidonia

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	S	Ca	TOC	Cu	Sr
Average Pos. ZH	1.0 wt%	2.6 wt%	2.9 wt%	26.7 ppm	201.8 ppm
Average Pos. NB	2.5 wt%	6.6 wt%	8.7 wt%	47.3 ppm	397.5 ppm

	Cd	U	Mo	Fe	As
Average Pos. ZH	0.2 ppm	2.4 ppm	3.7 ppm	5.2 wt%	29.3 ppm
Average Pos. NB	0.9 ppm	5.0 ppm	18.4 ppm	3.8 wt%	11.3 ppm