Predicting properties of faults in sand-shale sequences: case studies from the Rotliegend, Dutch Southern North Sea area

A. Silvius[1,3], K. van Ojik[1], Y. Kremer[2] & Z. Shipton[2]
1: exploration@ebn.nl, EBN, Daalsesingel 1, 3511 SV Utrecht, Netherlands
2: Department of Civil and Environmental Engineering, University of Strathclyde, 75 Montrose Street, Glasgow, G11XJ, United Kingdom
3: Department of Earth Sciences, Utrecht University, Heidelberglaan 2, 3584 CS Utrecht, Netherlands

Introduction

Understanding fault sealing and permeability is key for evaluating reservoir compartmentalization, structural trap integrity and hydrocarbon migration pathways.

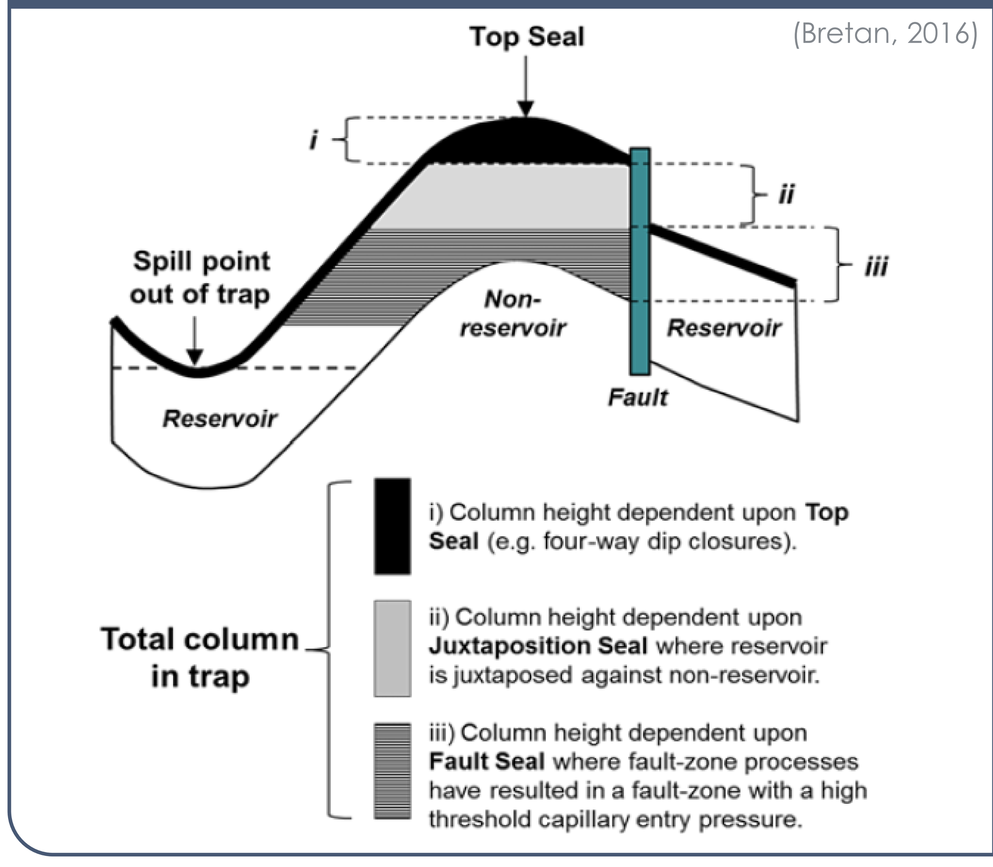
Existing fault seal evaluation tools (e.g. SGR, SSF, CSP) are reliable in conditional circumstances and do not usually quantify their inherent level of uncertainty. Current algorithms, particularly those focusing on clay smearing, depend largely on published calibrations to e.g. shallow marine sand-shale sequences from the Brent Province [5] or laboratory measurements [6]. Properties and conditions of Permian and Triassic mixed fluvial/Aeolian rocks are not necessarily honored by these existing fault seal algorithms. A collaborative Msc. project evaluates fault sealing properties in Rotliegend fields based on fault fabric and architecture.

Project aim

Predicting fault sealing and fault permeability by incorporating fault fabric and architecture.

Industry workflows may be improved by applying a process-based fault characterization.

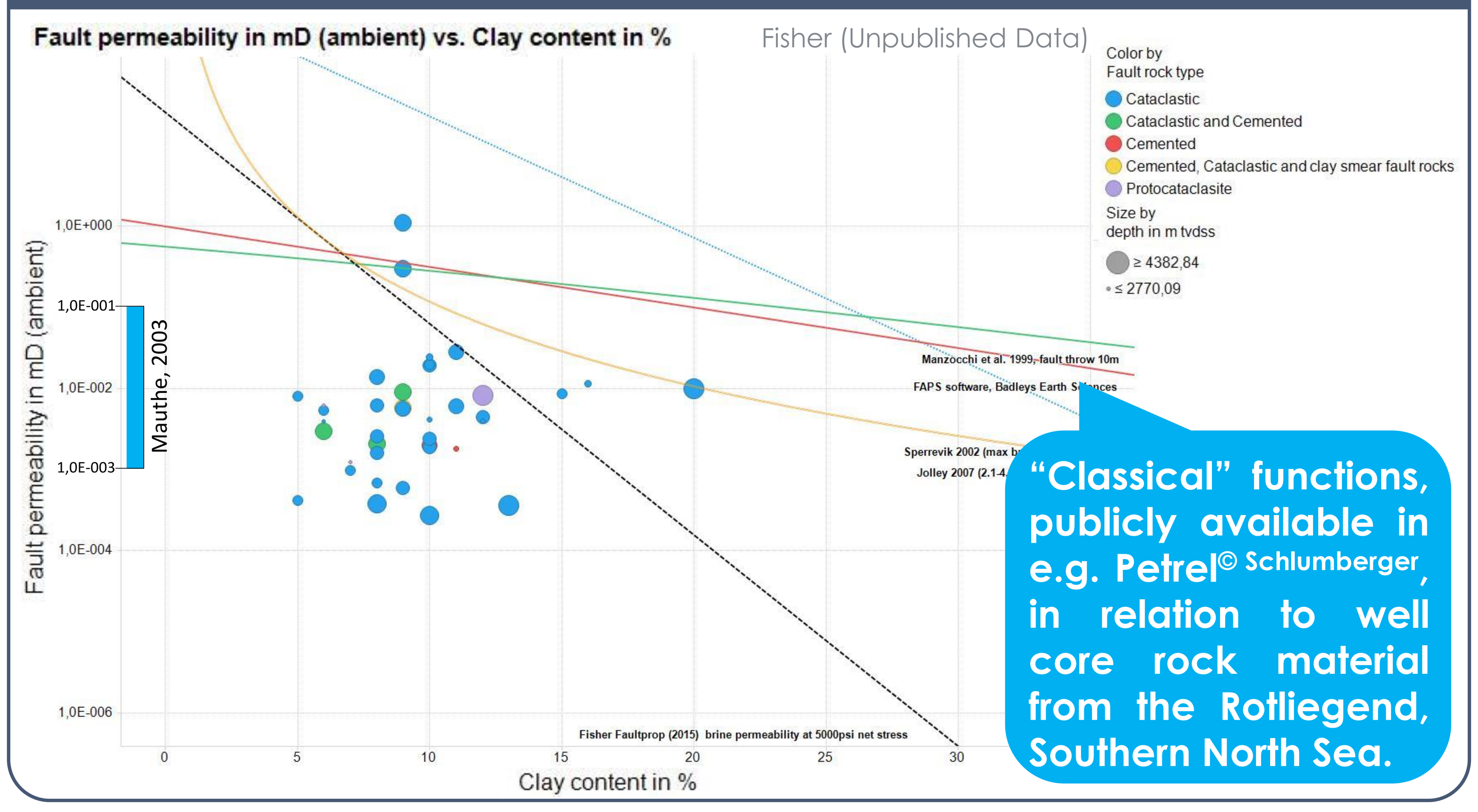
Definition of fault sealing



Fault sealing occurs where fault-zone processes have resulted in a fault-zone with a high threshold capillary entry pressure. This process is defined at an area where reservoir-against-reservoir juxtaposition takes place.

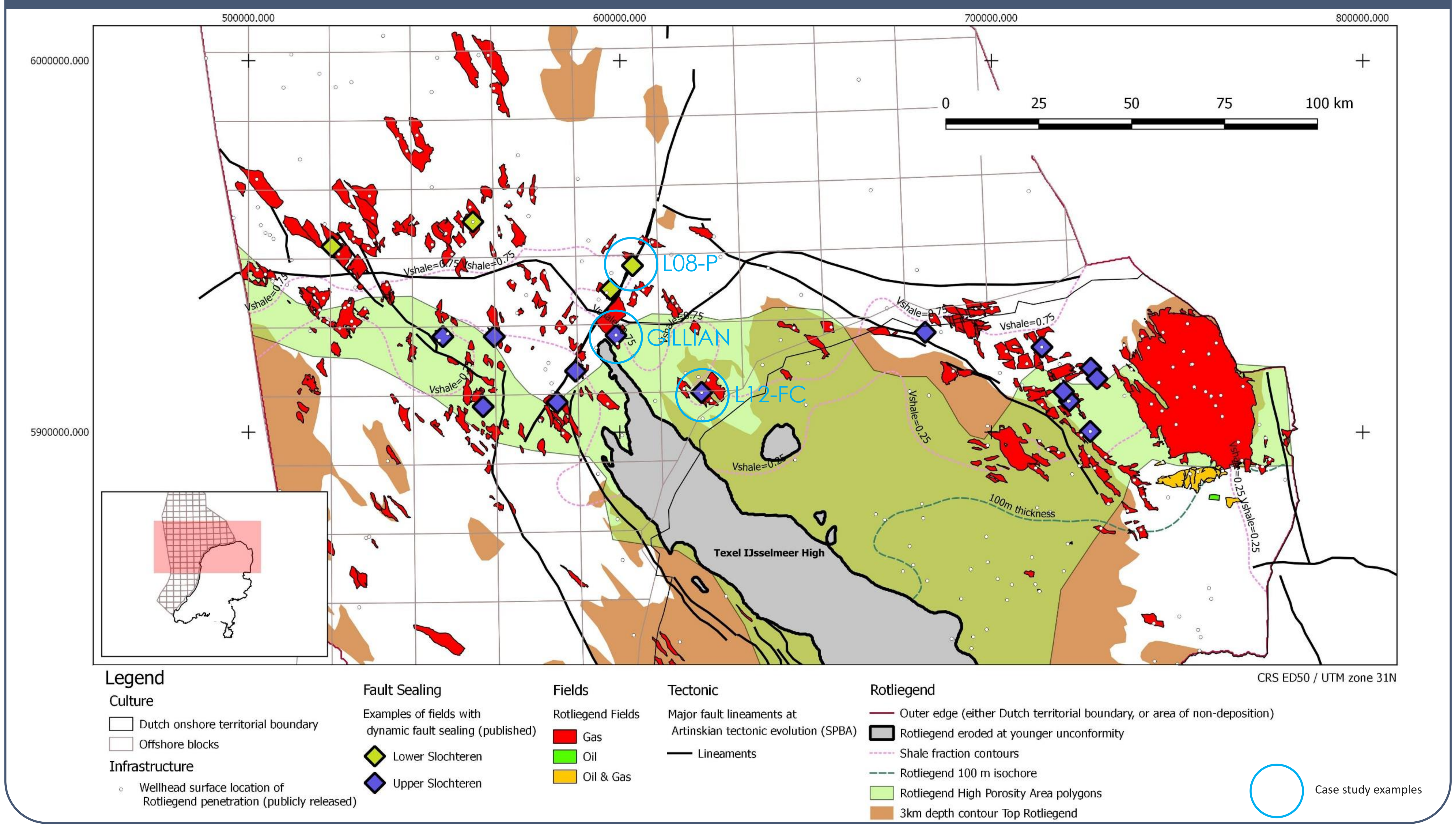
Hydrocarbon leakage through a water-wet fault-zone occurs when the excess (buoyancy) pressure generated by the hydrocarbon column exceeds the capillary threshold pressure of the fault-zone material.

Notional empirical relations



Catalogue - Rotliegend fields

Sealing faults in relation to general (paleo)geography



Methodology

The project is carried out by firstly building a catalogue of show-case proven examples illustrating various aspects of fault sealing (see image). Including, but not limited to, faults acting as a barrier or baffle to pressure communication and/or hydrocarbon flow over the geological and/or production timescale, fault collapse and juxtaposition sealing.

A better understanding of fault sealing and fault permeability may be achieved by reviewing show-case examples from the Permian a/o Triassic in detail. The collection of key parameters such as burial depth, host rock clay content, sand and shale bed thickness, fault geometry etc., will allow comparison of fault rock type and associated sealing potential between the outcrop based fault characterization and more commonly used predictors such as SGR.

Process-based fault characterization

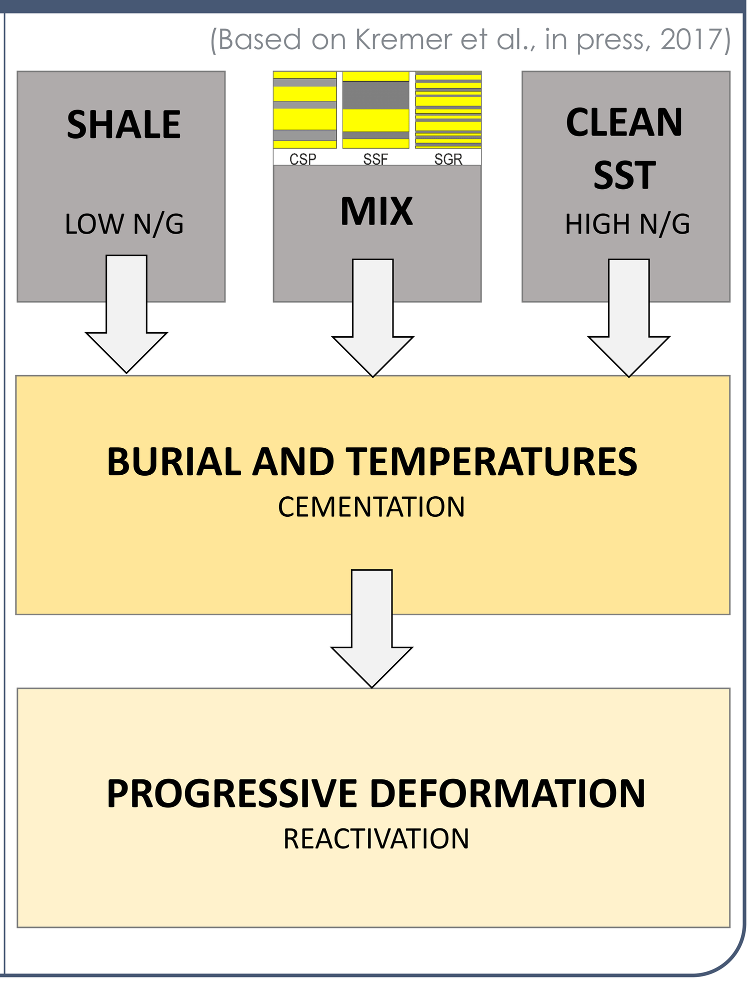
Flowchart

Flowchart for process-based characterization of fault sealing and fault permeability, based on outcrop studies.

1) Identify shale content and determine the type of fault deformation.
2) Asses the degree of cementation (burial and post-faulting temperature)
3) Progressive deformation

questions arising:

- *Is the input data to the flowchart relevant for Rotliegend cataclasites/fault rocks?*
- *What about the scalability of outcrop vs. subsurface data?*
- *What are the levels of uncertainty and sensitivity?*



Deliverables & Timeline

2017	November December	Catalogue of proven/likely/probable examples of static/dynamic fault sealing, selection of three candidates for detailed analysis.
2018	December January February	Database with fault geometry properties
	April	Improved (calibrated) process-based characterization of fault sealing
	May	Masterthesis report

References see abstract