Core scale EME for IOR

Experiment – Modelling - Experiment

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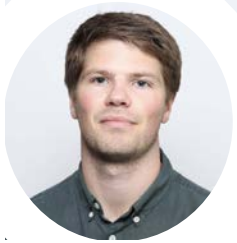

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WHY COLLABORATE?

RESULTS

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HOW?

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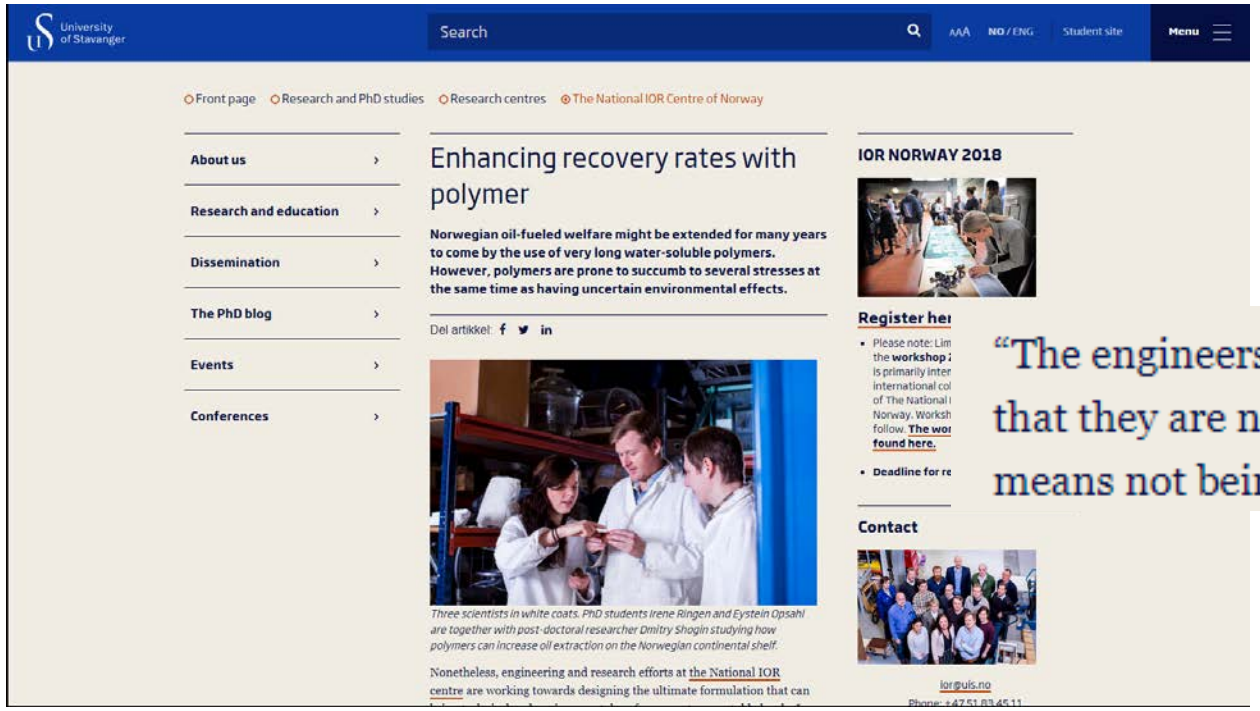
WHY COLLABORATE?



"The engineers observe many interesting effects regarding polymers that they are not able to explain. Not being able to explain these effects means not being able to predict them, which is what you want",

Dmitry Shogin
(UiS/ the National IOR Centre)

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WHY COLLABORATE?

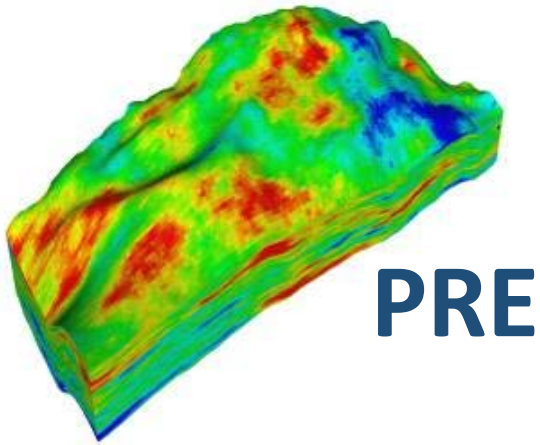
EXPERIMENTS

Test ideas and develop EOR methods

NUMERICAL MODELLING

Validate proposed hypotheses and explain observations

CORE SCALE SIMULATION



PREDICT IOR ON LARGER SCALES

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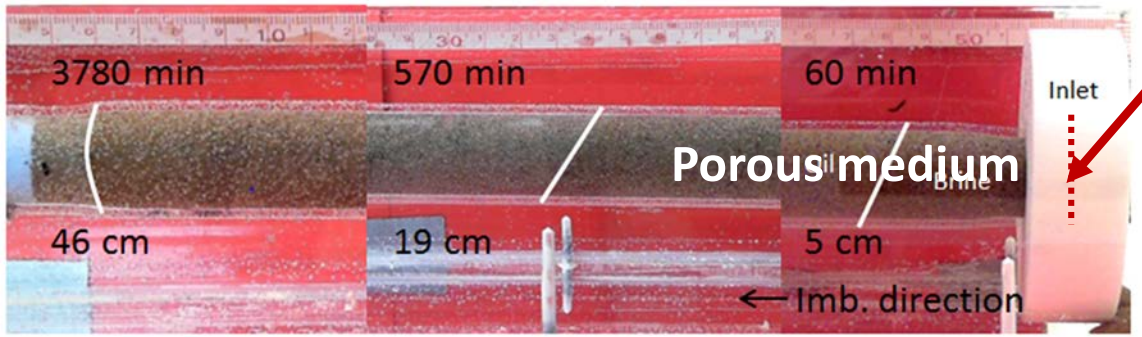
RESULT EXAMPLE

Sand pack in glass tube

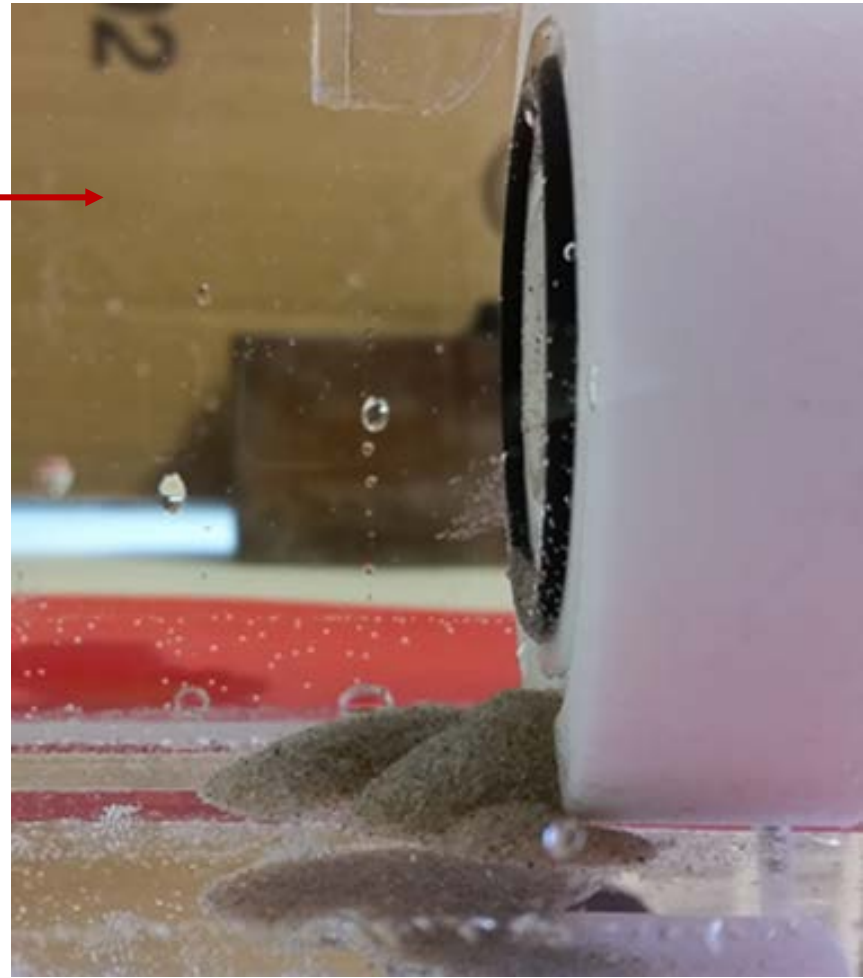
Direct visualization of front development



Spontaneous imbibition: the process where a less-wetting fluid is displaced out of a porous medium by a more-wetting fluid due to capillary actions.

FILTER:
Glass
Metal mesh
Paper
Glass wool
#NOFILTER

Imbibing phase



Numerical modelling to quantify filter impact on flow.

RESULT EXAMPLE

"the simulations revealed that experimentally measured spontaneous imbibition was extremely sensitive to the experimental conditions, due to the high permeability and low capillarity of the sand packs. In particular, the presence of semi-permeable filters at the boundaries affected the imbibition rate and profiles, end recovery and counter-current production."

SPE-188625-MS

Numerical Interpretation of Laboratory Spontaneous Imbibition - Incorporation of the Capillary Back Pressure and How it Affects SCAL

UiS PhD student

UiS Post Doc

UiS MSc students

The National IOR Centre

Pål Ø. Andersen[1,2], Bergit Brattekås[1,2], Kenny Walrond[2], Daisy S. Aisyah[2], Oddbjørn Nødland[1,3,4], Arild Lohne[1,4], Håkon Haugland[5], Tore L. Føyen[5], and Martin A. Fernø[5]

IRIS Researcher

UiB MSc student

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UiB Professor

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[2] Dept. of Petroleum Engineering, University of Stavanger, Norway
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This paper was prepared for presentation at the Abu Dhabi International Petroleum Exhibition & Conference held in Abu Dhabi, UAE, 13-16 November 2017.

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WHY COLLABORATE?

Can modelling benefit from experiments?

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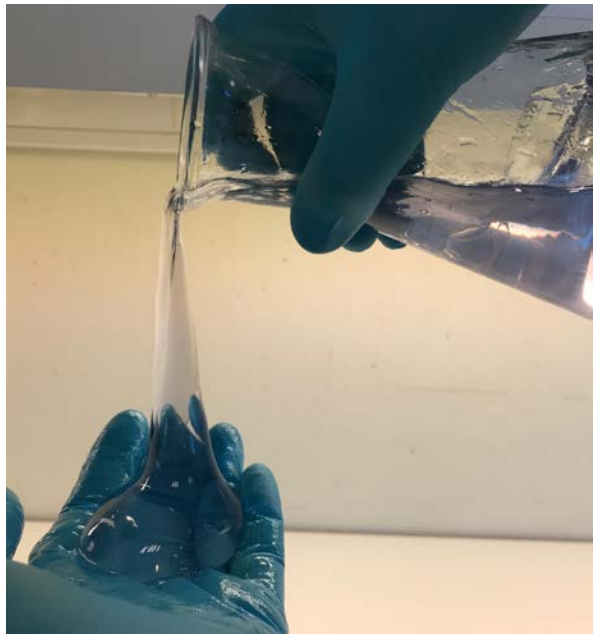
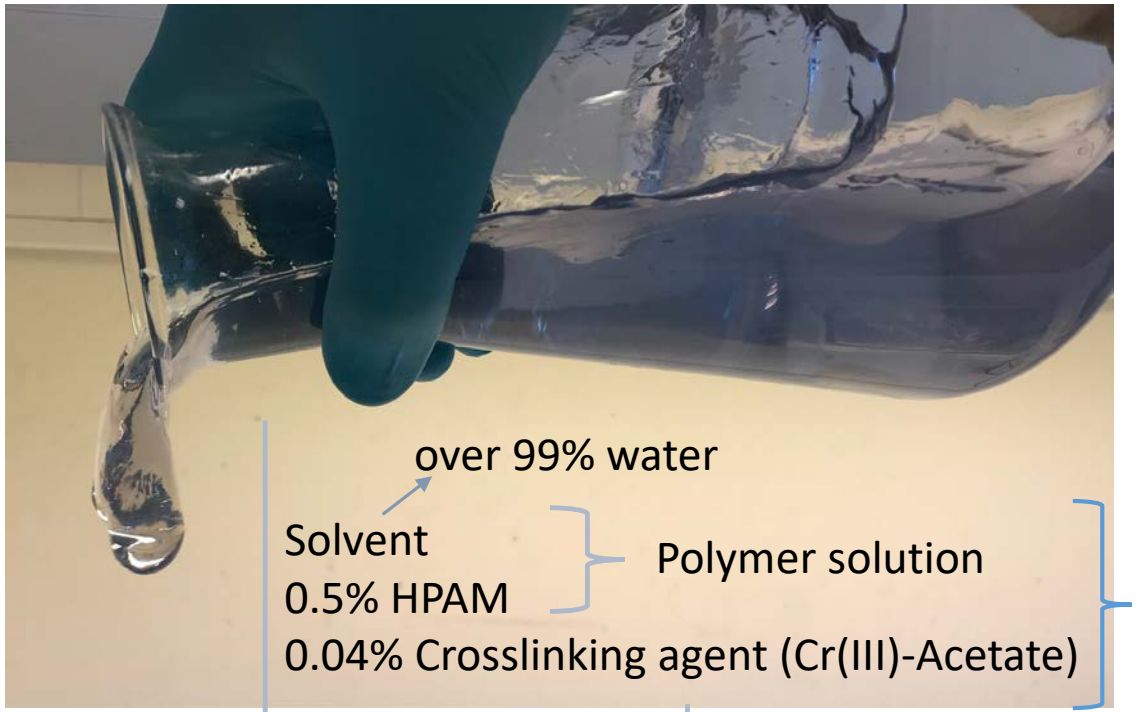
RESULT EXAMPLE

Polymer gel



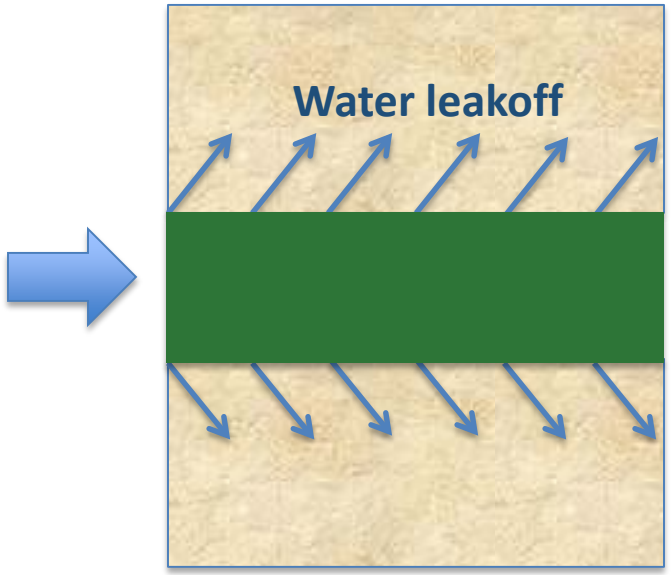


Gelant

Properties similar to polymer solution → flows through rock

RESULT EXAMPLE

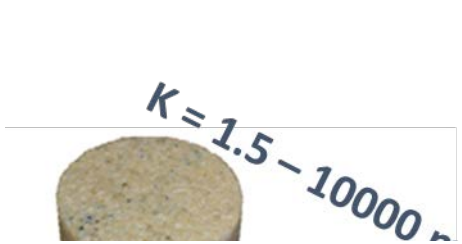
Gel placement in a fracture to reduce fracture conductivity



Seright (2003)

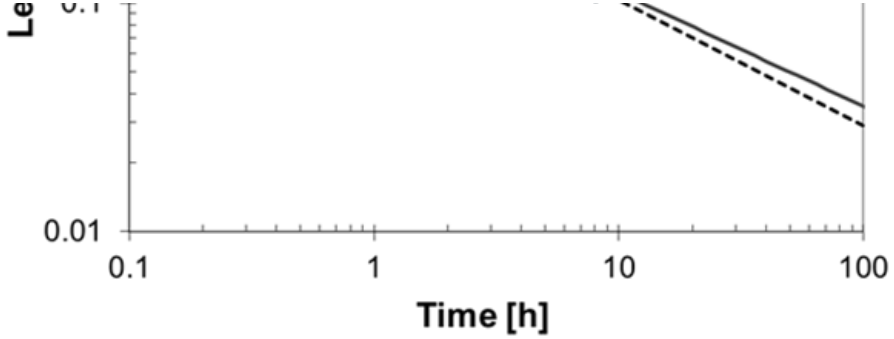
RESULT EXAMPLE

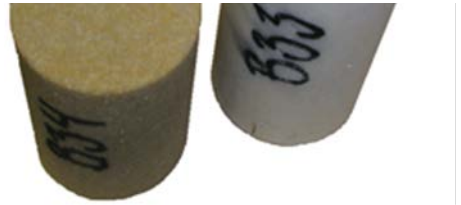
Gel placement in a fracture to reduce fracture conductivity

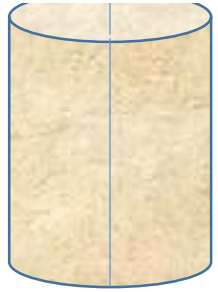


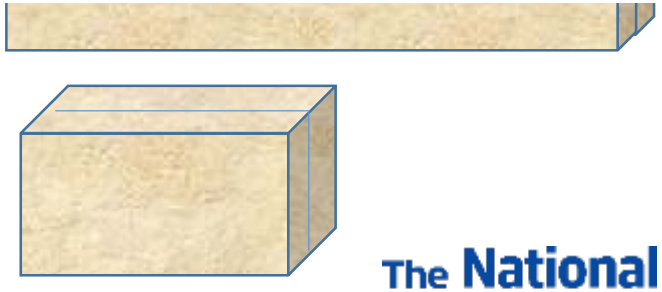
CORE PLUGS HAVE THIS FAR BEEN FULLY SATURATED BY WATER.

WHAT IF WE HAVE OIL IN THE MATRIX?









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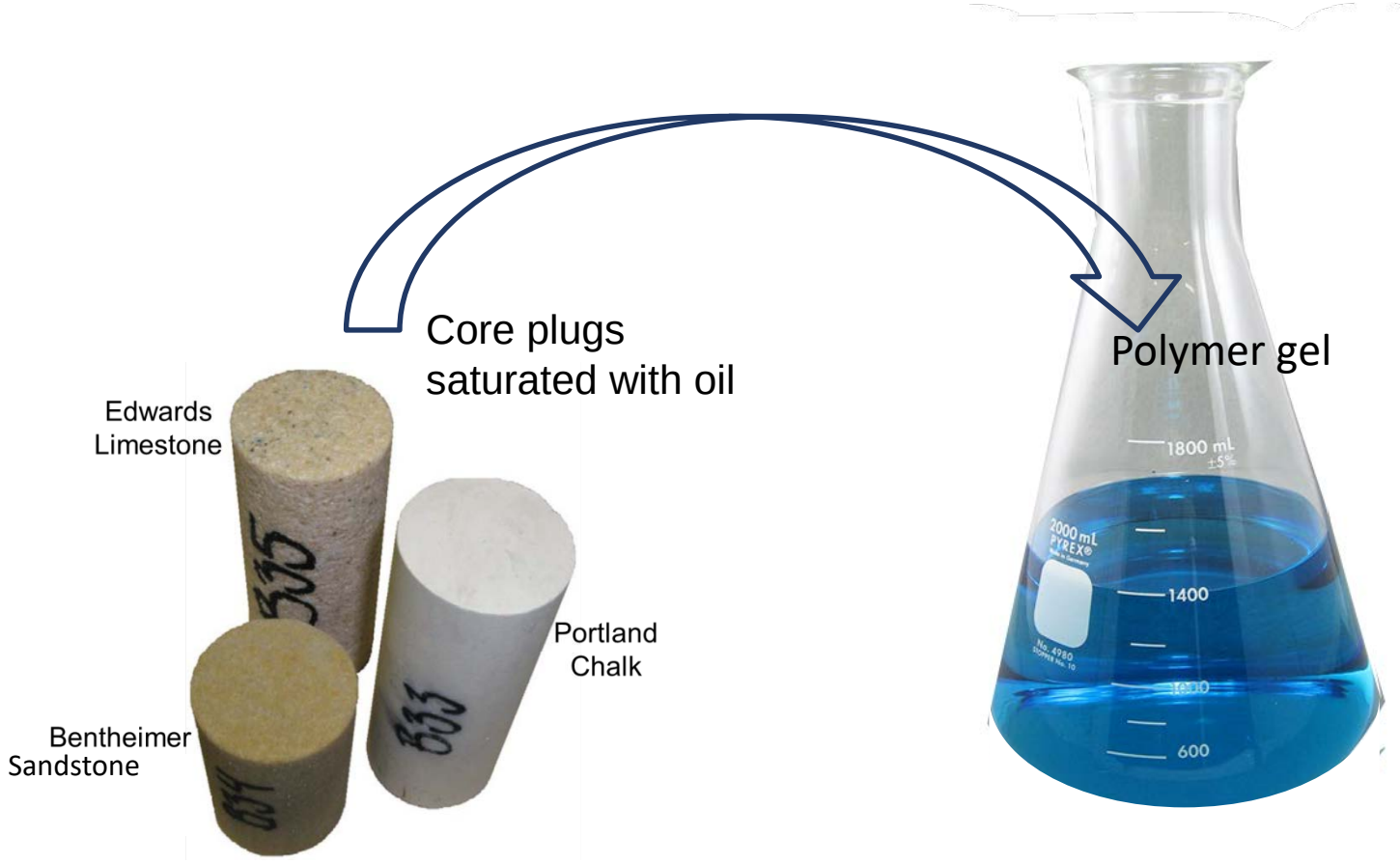
RESULT EXAMPLE



* collaborative experimental research by the Reservoir Physics Research Group at UiB and Dr. Randall S. Seright (PRRC, New Mexico Tech., USA). Published in SPE Jpurnal: SPE-153118

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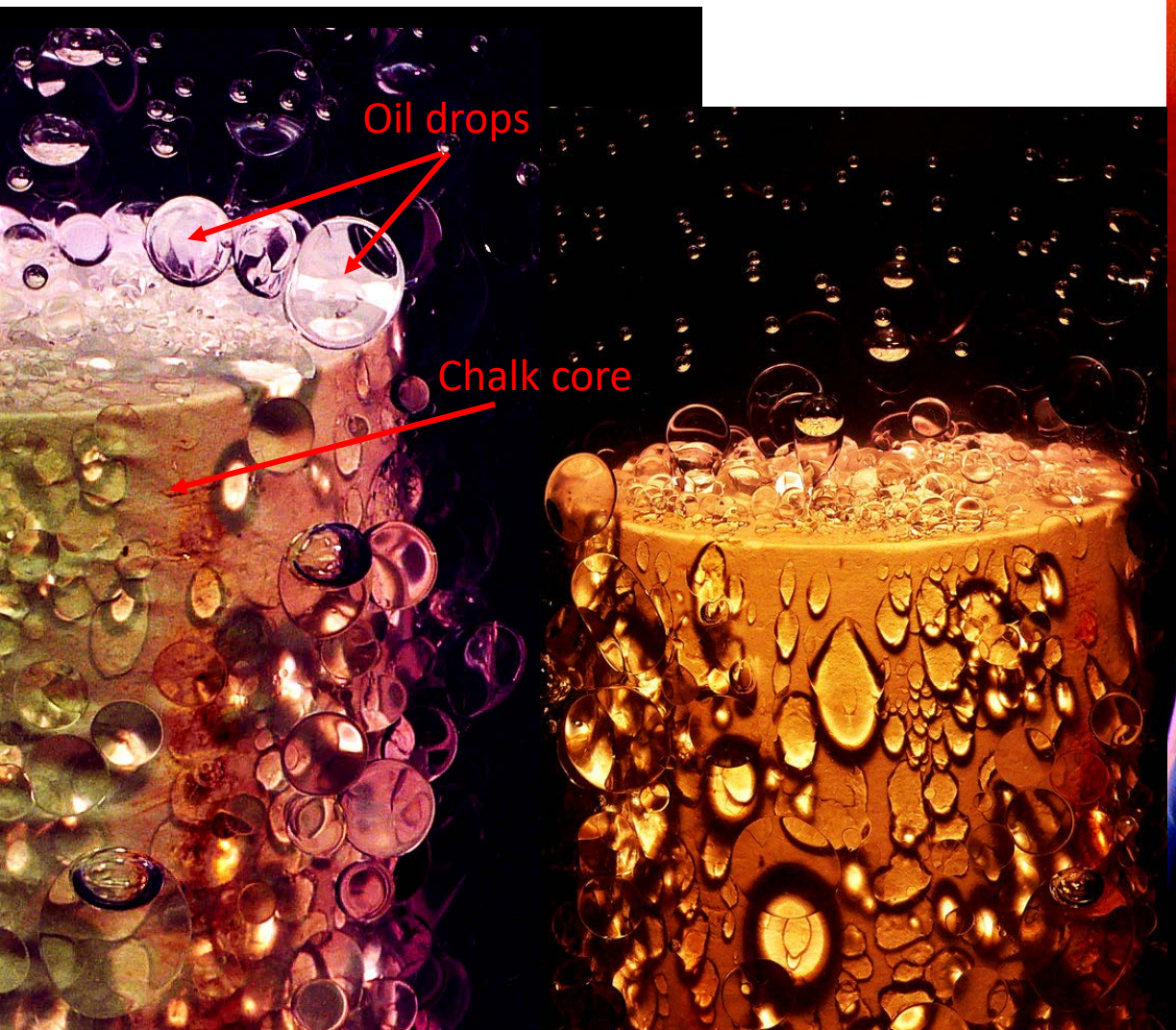
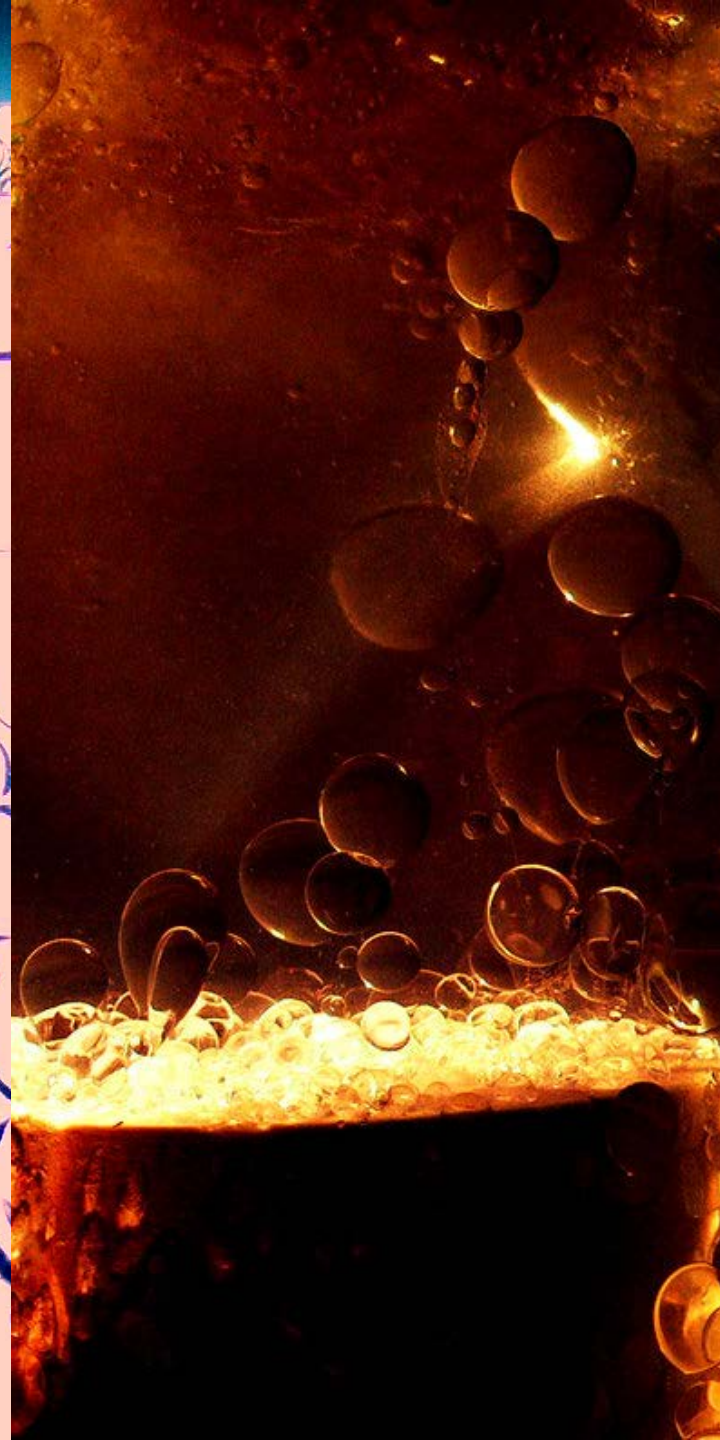
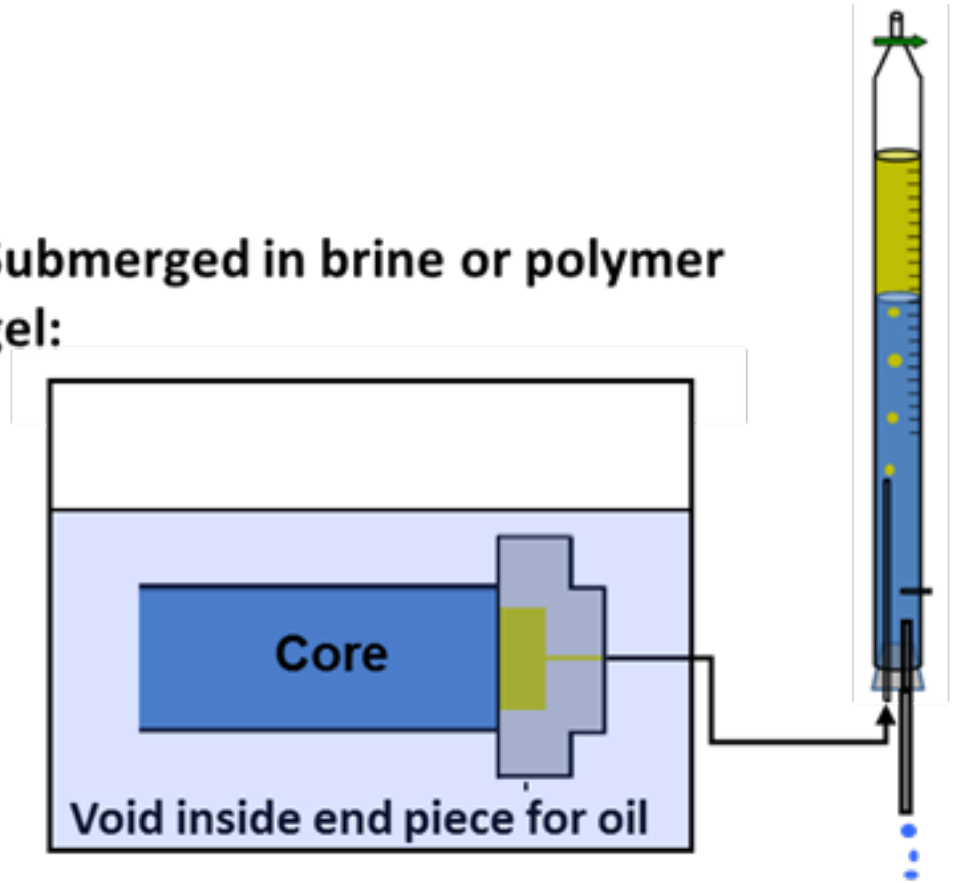
RESULT EXAMPLE



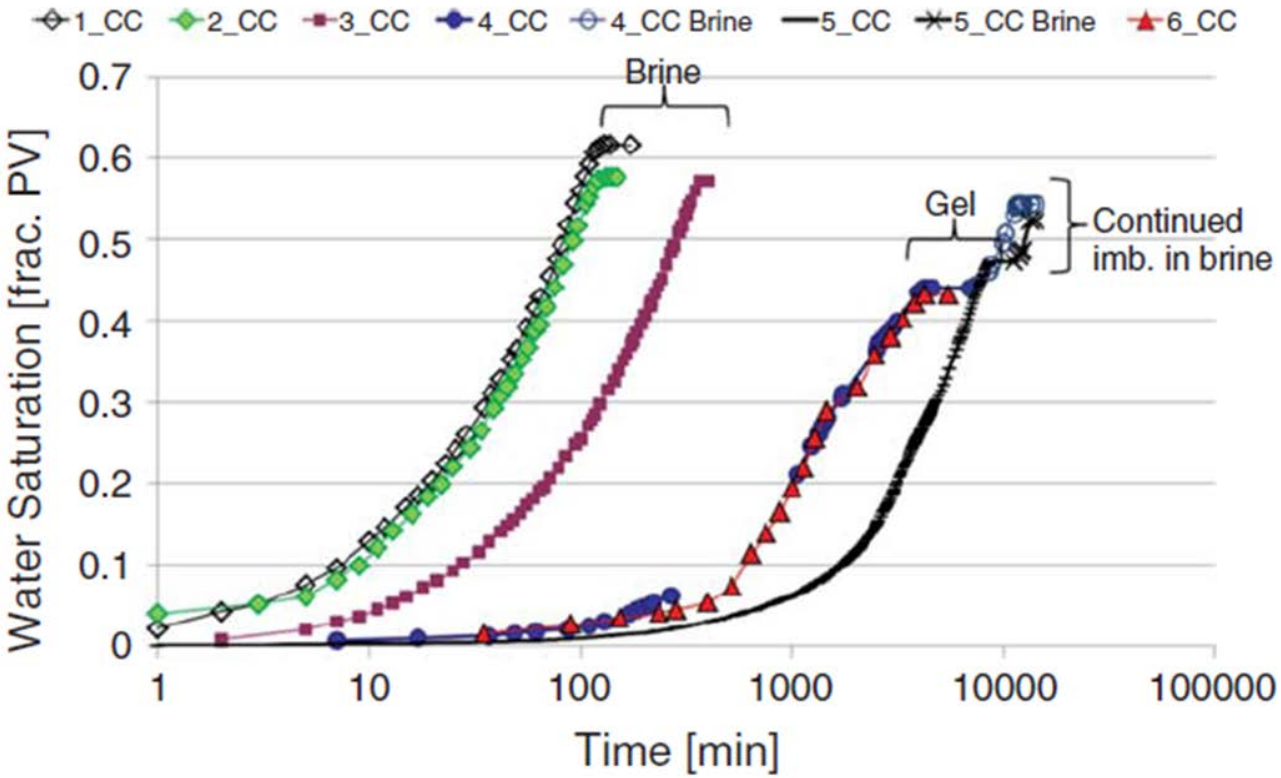


RESULT EXAMPLE

Submerged in brine or polymer gel:



Experiment



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Modelling

SPE-190189-MS

Core Scale Simulation of Spontaneous Solvent Imbibition from HPAM Gel

Pål Østebø Andersen[1,2], Arild Lohne[2,3], Arne Stavland[2,3], Aksel Hiorth[1,2,3] and Bergit Brattekås[1,2,4]
[1] Dept. of Energy Resources, University of Stavanger, Norway
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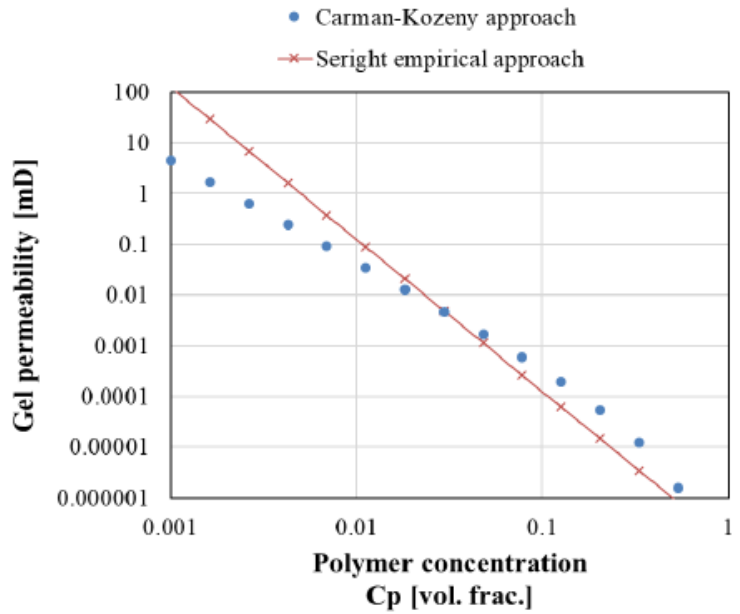
[4] Dept. of Physics and Technology, University of Bergen, Norway

This paper was prepared for presentation at the SPE Improved Oil Recovery Conference held in Tulsa, Oklahoma, USA, 14-18 April 2018.



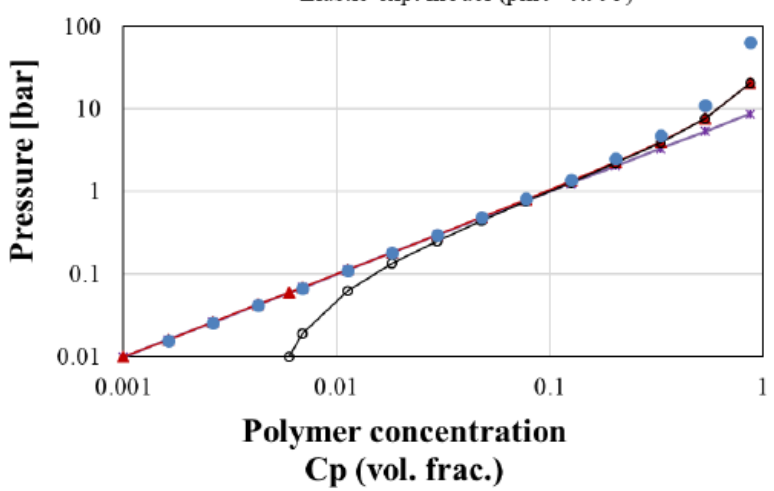
$$K_{gel} = \frac{\tau_{gel}}{2\tau\left(1-\phi_{gel}\right)^2 S_0^2} = \frac{(\tau_p)}{2\tau C_p^2 S_0^2},$$

→ Reduced gel porosity and permeability

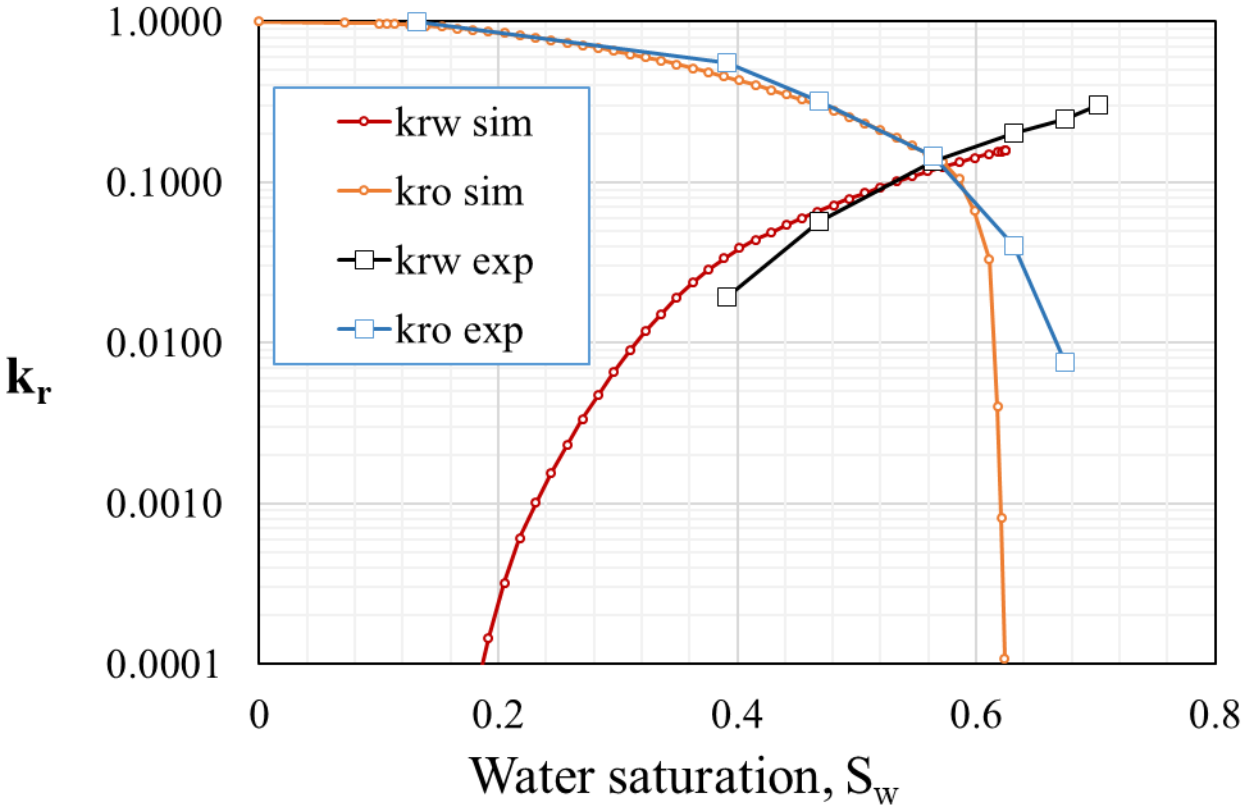
- Gel structure carries a stress from surroundings, but is supported by pore pressure. Deforms according to net effective stress and a compressibility:

$$p_m - p_w = p_{nob},$$

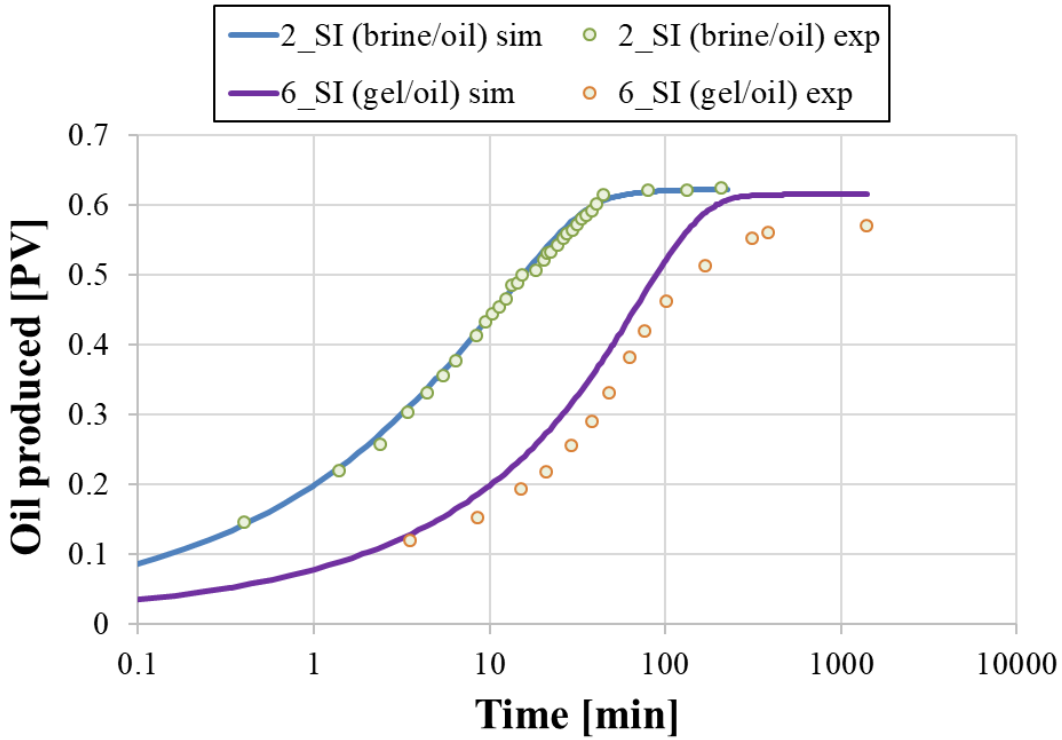
$$\phi_{gel} = \phi_{gel,0} \exp\left(-n_{gel} p_{nob}\right),$$

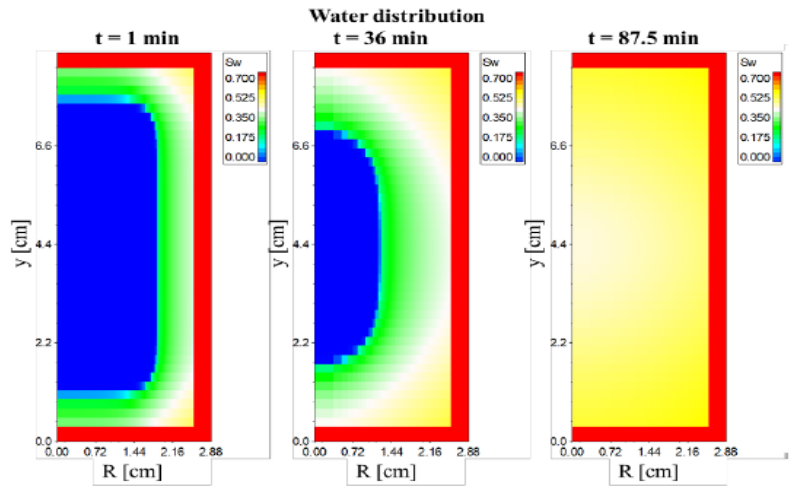


Baseline matching



Simulations





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RESULT EXAMPLE

SPE-190256-MS

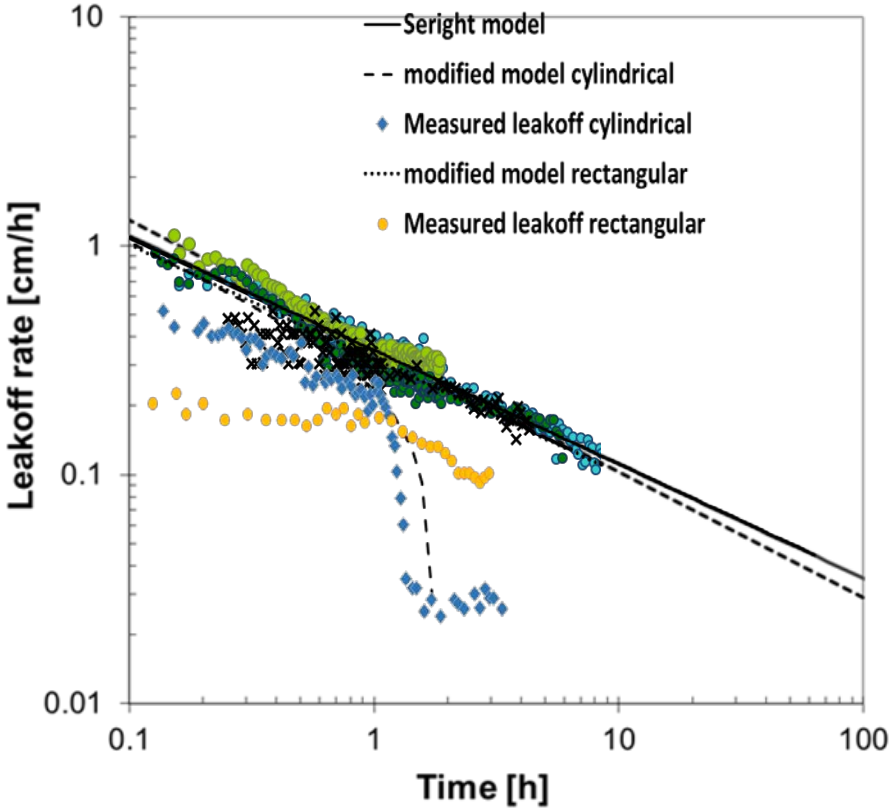
Solvent Leakoff during Gel Placement in Fractures: Extension to Oil-Saturated Porous Media

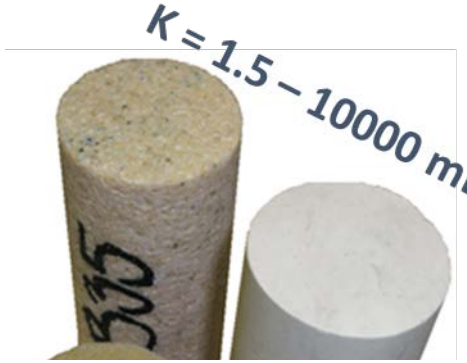
Brattekås, B.[1], Ersland, G.[2] and Seright, R.S.[3]

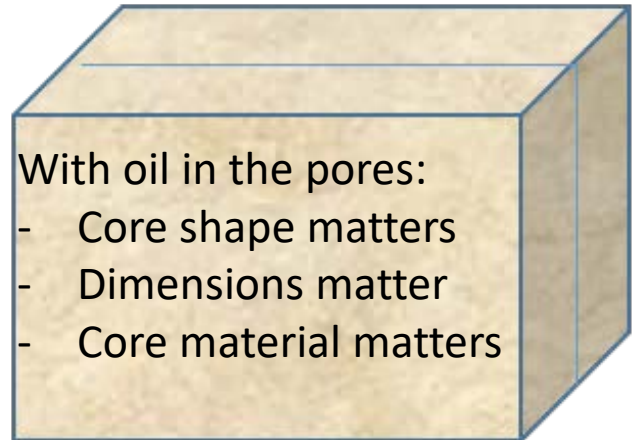
[1]The National IOR Centre of Norway, Dept. of Energy Resources, University of Stavanger, Norway,
[2]Dept. of Physics and Technology, University of Bergen, Norway

[3]Petroleum Recovery Research Center (PRRC), New Mexico Insitute of Mining and Technology, NM, USA

New experiments







How can we predict leakoff during gel injection in fractured reservoirs with an oil saturation?

- **Cannot rely on conventional model**
- **Cannot implemet experimental findings directly**

HOW?

Experimentalists and modelers: can we all just get along?

James M. Bower and Christof Koch

James M. Bower and Christof Koch are with the Computation and Neural Systems Program, California Institute of Technology, Pasadena, CA 91125, USA.

How can the interaction between theoretical neuroscientists and their experimental counterparts be improved? This article discusses a number of suggestions relating to the presentation of data in experimental studies. In particular, published data should account for the diversity of response properties encountered, rather than concentrating on the 'representative' response, as well as emphasizing the stochastic nature of neurons by routinely including raw, unprocessed data from individual trials, which show the degree of variability prior to averaging.

makes extracting information for purposes of modeling a frustrating process. In anticipation of this special modeling issue of *TINS*, we requested suggestions from numerous colleagues for ways to increase the usefulness of published experimental results for modeling purposes. The results of that survey form the basis for this article.

These comments fall into three general categories:

(1) a list of experiments judged to be particularly critical to substantiate or falsify specific theories or models:

OIKOS

SYNTHESISING ECOLOGY

Editor's Choice and Forum | Full Access

On the missing link in ecology: improving communication between modellers and experimentalists

Jan Heuschele, Mikael T. Ekvall, Patrizio Mariani, Christian Lindemann

First published: 21 March 2017 | https://doi.org/10.1111/oik.03885

A particular concern we found from this research was that experimentalists do not seem to be drawing inspiration from modelling papers. Surveyed experimentalists stated that these papers were difficult to understand and that they were sceptical about the model being a realistic representation of the system.

← Sense of place: the ecosystem service to align social and conservation values?

Qaeco's favourite papers of 2017 →

Modellers v.s. Experimentalists – why can't we all just get along?

Posted on November 14, 2017 by qaecology

Are modellers trying to steal your data?

On the dialog between experimentalist and modeler in catchment hydrology: Use of soft data for multi-criteria model calibration

Jan Seibert*
Swedish University of Agricultural Sciences, Department of Environmental Assessment, S-750 07 Uppsala, Sweden

Jeffrey J. McDonnell
Oregon State University, Department of Forest Engineering, Corvallis OR 97331, U.S.A.

Revised version, submitted to Water Resources Research

March, 2002

"The dialog between experimentalist and modelers [in catchment hydrology] has been minimal to date. The experimentalist often has a highly detailed yet highly qualitative understanding of [the] processes…… While modelers often appreciate the need for 'hard data'"

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NUMERICAL MODELLING

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EXPERIMENT

MODELLING

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Lab to Field: CO_2 Foam EOR Field Pilots

OBJECTIVE

Cost-effective "Roadmap for Success" for CO_2 EOR implementation on Norwegian Continental Shelf through **onshore field trials in Texas**

WHY TEXAS?

- **CO_2 is commercially available; w/infrastructure**
- **Up-scaling; major challenge in oil recovery**
- **Fraction of costs of off-shore field tests**
- **Fast results: short inter-well distances**
- **30 years experience in Texas on CO_2 EOR**

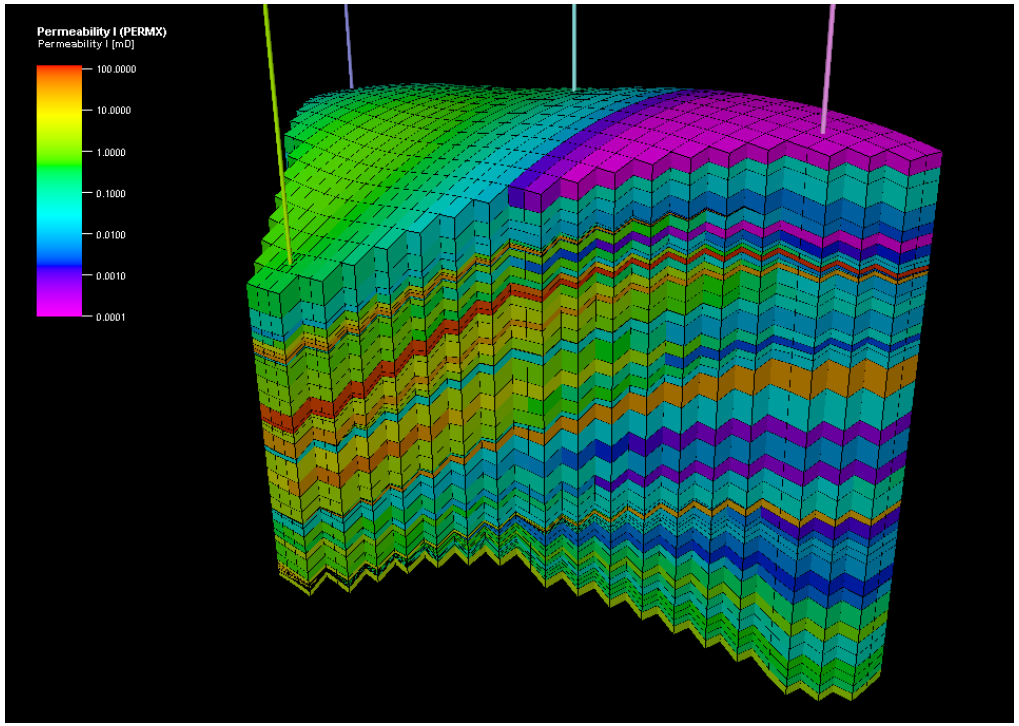
COLLABORATORS

U. of Bergen	**Total**	**Stanford U.**
U. of Bordeaux	**Rice U.**	**National IOR centre**
U. of Houston	**TU Delft**	**Schlumberger**
Statoil	**UT Austin**	**Shell**

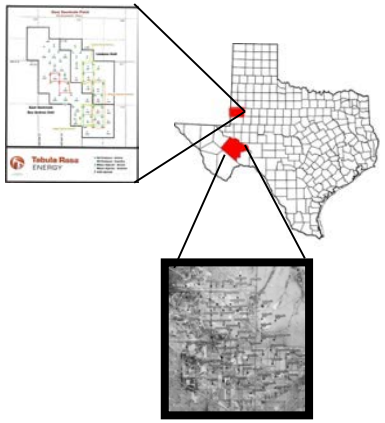
FUNDING 15MNOK

Norwegian Research Council, CLIMIT program
Oil Industry (Shell, Total, Schlumberger, Statoil)
+ local independent operators

1981 1987 2014



East Seminole Well Location Map



Ft. Stockton Well Location Map

Simulation Results

EFFICIENT Oil Production:
CO_2 Foam EOR increase sweep efficiency

MORE CO_2 stored:
Displace water to increase CO_2 storage volume

Laboratory Results

MORE Oil produced:
CO_2 Foam EOR produces 10-30% additional oil after waterflooding

FASTER Production
Operational times reduced up to 90%.

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Michael Jian (PhD)
Connie Wergeland (MSc)
Anders Frøland (MSc)
Andreas G. Polden (MSc)

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Mohan Sharma (PhD)
Lars Petter Grønvigh (MSc)
Anna Bang (MSc)
Max Castro (MSc)
Stine Kristiansen (MSc)

The 2018 user partners and observers:

NEPTUNE ENERGY

wintershall

TOTAL

eni norge

HALLIBURTON

Schlumberger

ConocoPhillips

Lundin Norway

Statoil

DEA

AkerBP

NORWEGIAN PETROLEUM DIRECTORATE

petoro

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Acknowledgement:

The authors acknowledge the Research Council of Norway and the industry partners, ConocoPhillips Skandinavia AS, Aker BP ASA, Eni Norge AS, Maersk Oil, a company by Total, Statoil Petroleum AS, Neptune Energy Norge AS, Lundin Norway AS, Halliburton AS, Schlumberger Norge AS, Wintershall Norge AS, and DEA Norge AS, of The National IOR Centre of Norway for support.