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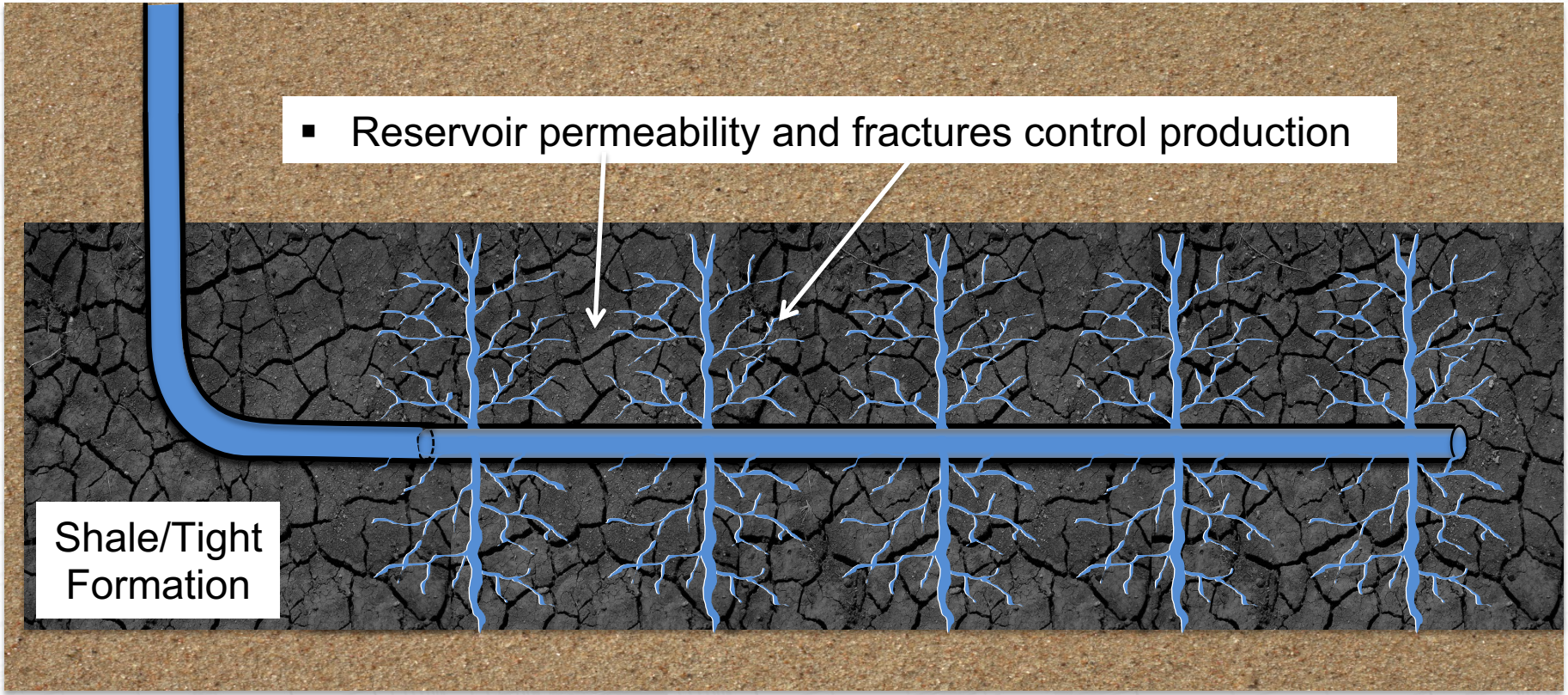
A Revolutionary New Core Analysis Method for Unconventional Hydrocarbon Reservoirs Based on Rate-Transient Analysis Theory

C.R. Clarkson, A. Vahedian, A. Ghanizadeh, and C. Song
University of Calgary, Calgary, Canada

The integrated event for unconventional resource teams

Background

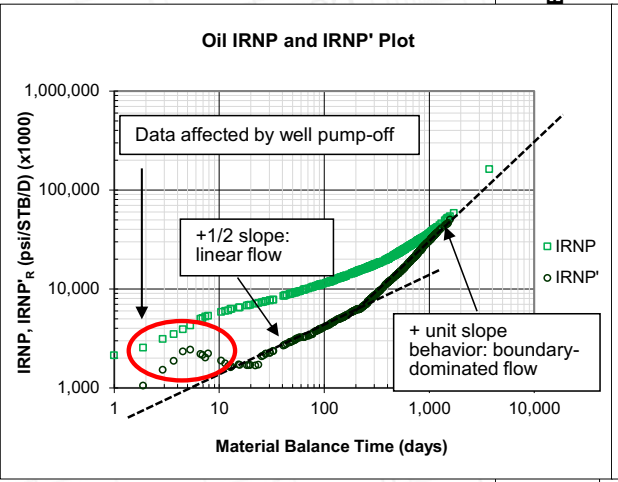

▪ Reservoir permeability and fractures control production
Shale/Tight Formation

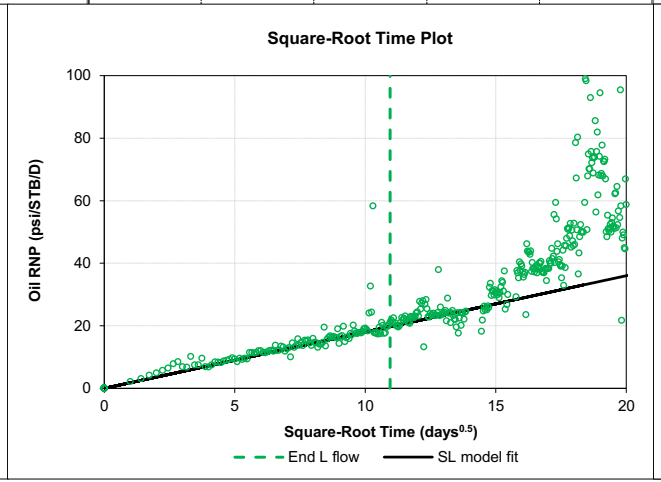
Background

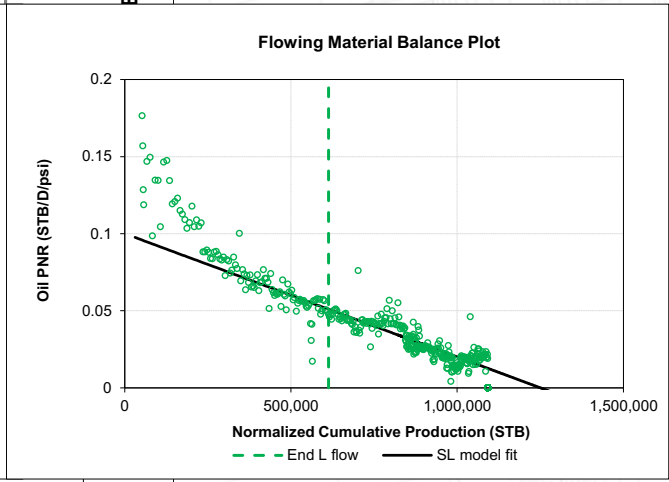
- Rate-transient analysis is a common method to extract reservoir and fracture information from well production (field data)

Flow-regime ID

RTA models for parameter extraction







Problem Statement

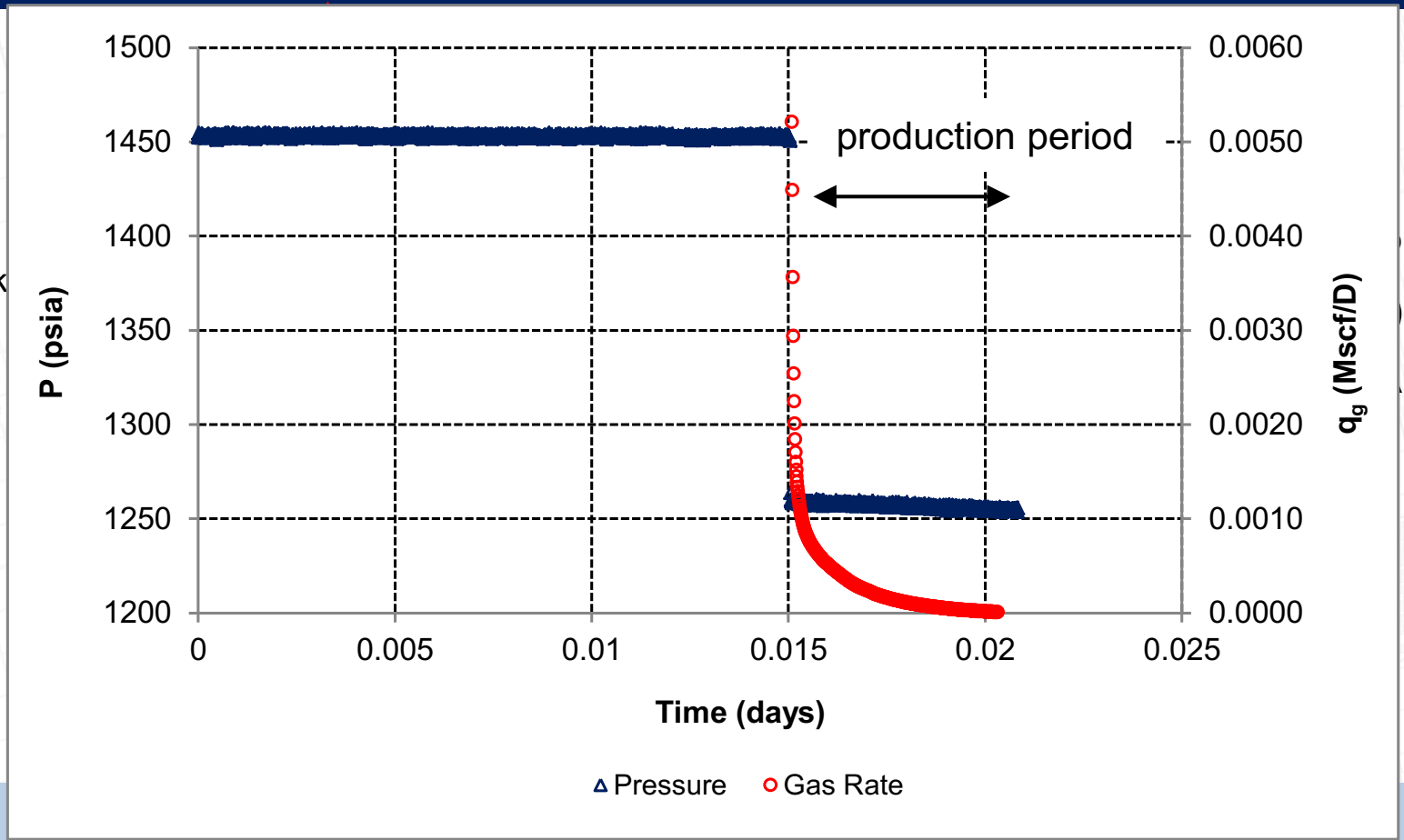
- **Laboratory data** is needed to provide **key data** for RTA models
- However, the experimental **boundary conditions** of conventional testing methods **do not match** conditions in the field
- Test times are **extensive** for low-permeability reservoirs
- **Flow regimes** in field are **not reproduced** in the lab
- Data is **not analyzed** in the **same way as field data**

- *Why can't experiments be designed to match field conditions?*

Solution

- We have designed an experimental apparatus that allows us to recreate field conditions, and analyze the data in the same way

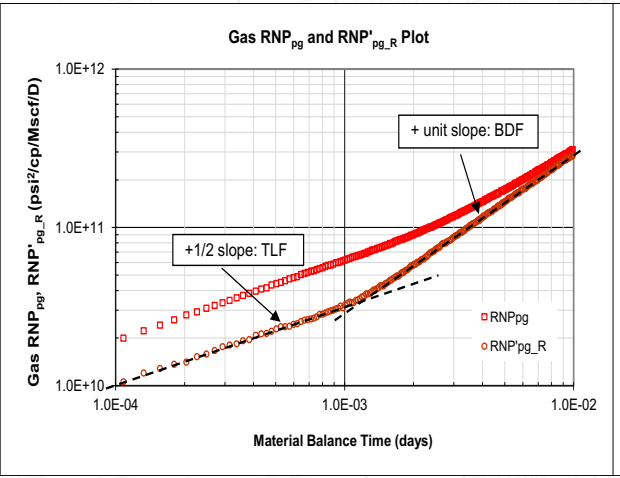
Solution


1500
1450
1400
1350
1300
1250
1200
P (psia)
0.0060
0.0050
0.0040
0.0030
0.0020
0.0010
0.0000
q_g (Mscf/D)
production period
0
0.005
0.01
0.015
0.02
0.025
Time (days)
Pressure
Gas Rate

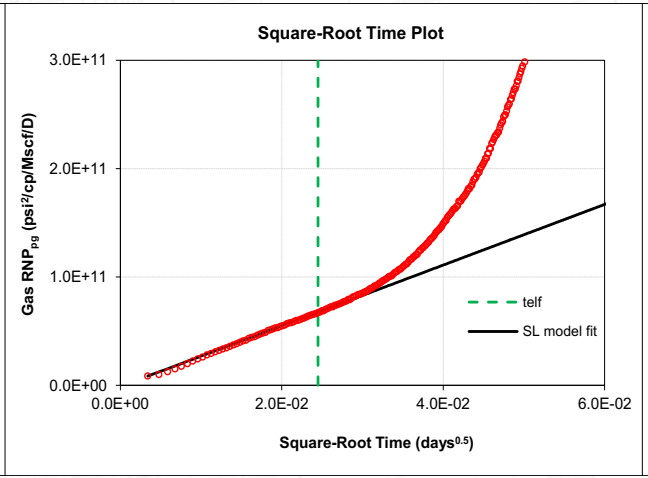
Proof-of-Concept Results

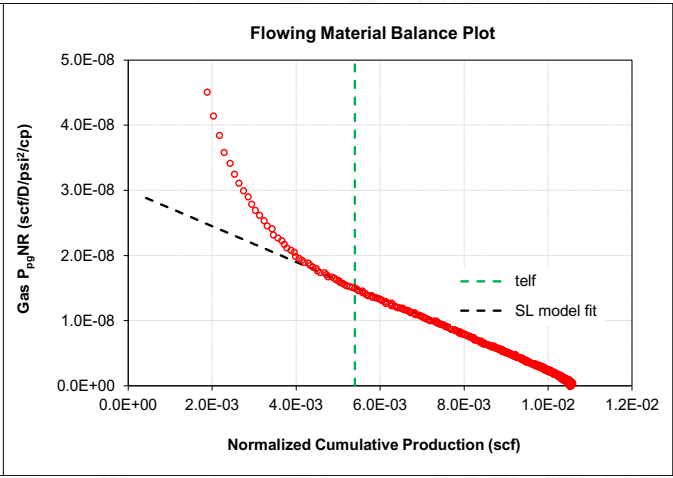
- **Advantage #1**: ***data and data analysis consistent with field analysis***

Flow-regime ID



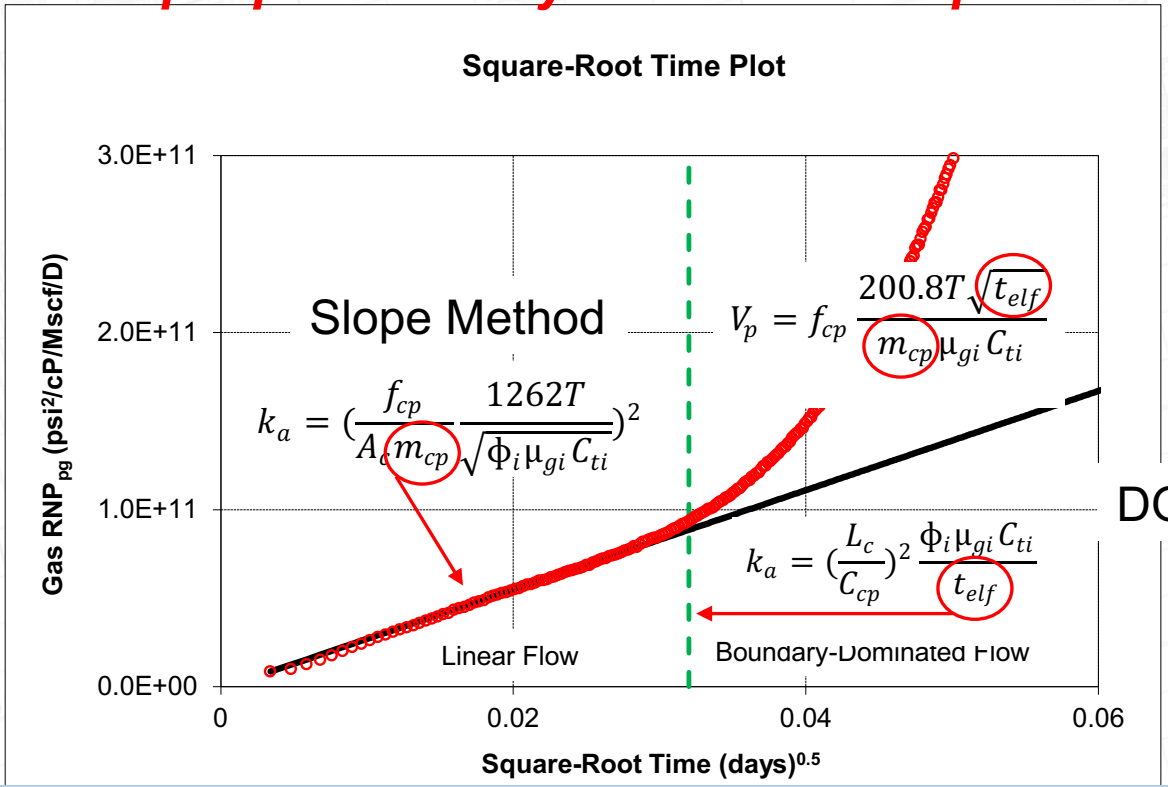
RTA models for parameter extraction





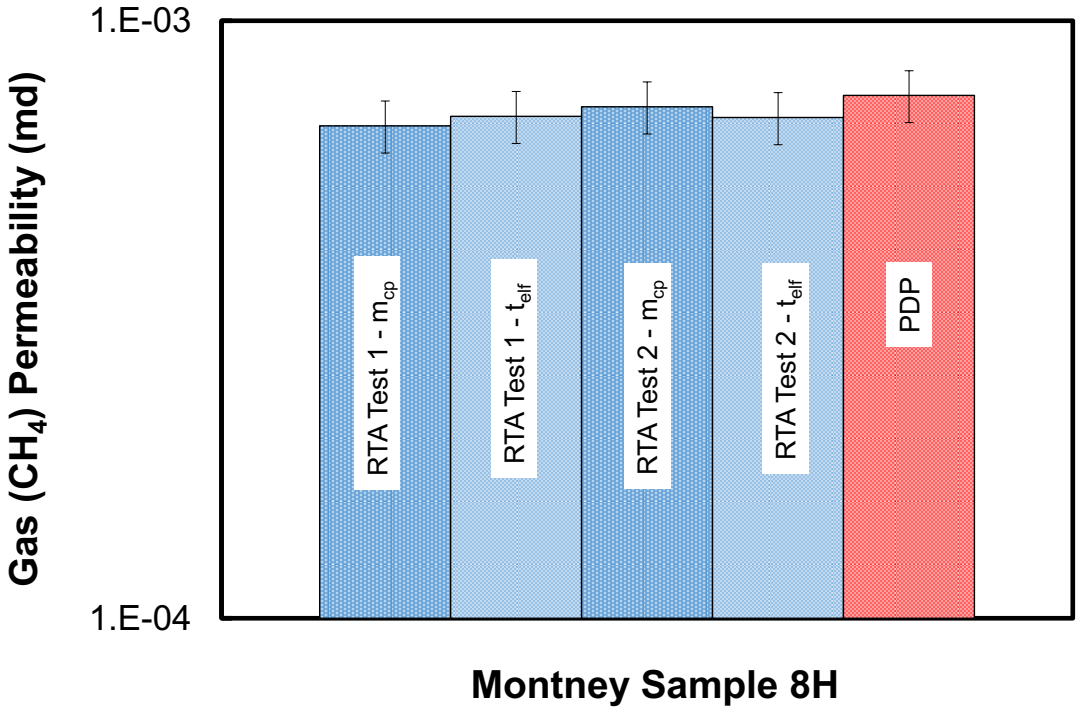
Proof-of-Concept Results

- **Advantage #2**: ***multiple permeability estimates and pore volume***



Proof-of-Concept Results

- **Advantage #3**: ***results repeatable and consistent with other methods***



Proof-of-Concept Results

- **Advantage #4**: ***speed – more tests can be done in a day***

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journal homepage: www.elsevier.com/locate/fuel

Full Length Article

A new low-permeability reservoir core analysis method based on rate-transient analysis theory☆

Christopher R. Clarkson*, Atena Vahedian, Amin Ghanizadeh, Chengyao Song

Department of Geoscience, University of Calgary, Calgary, Canada

Business Case

- Consistency between this core test and field testing ***improves reliability***
- Consistency between test conditions/analysis and field conditions/analysis ***increases marketability*** (RTA is familiar to most petroleum engineers)
- Speed of test ***increases throughput/number of measurements*** per day
- Protection status: ***Patent-Pending (Canada & US)***

Time is Money! – and yes, this is true for (service) companies too!

- **5-10 times faster** than routine industry practice ⟶ **3-5 additional tests/samples** per routine testing time
- Cost of **each test**: **$400**

SWOT Analysis

Strengths

- Reliability
- Marketability
- Speed

Weaknesses

- Dynamic range

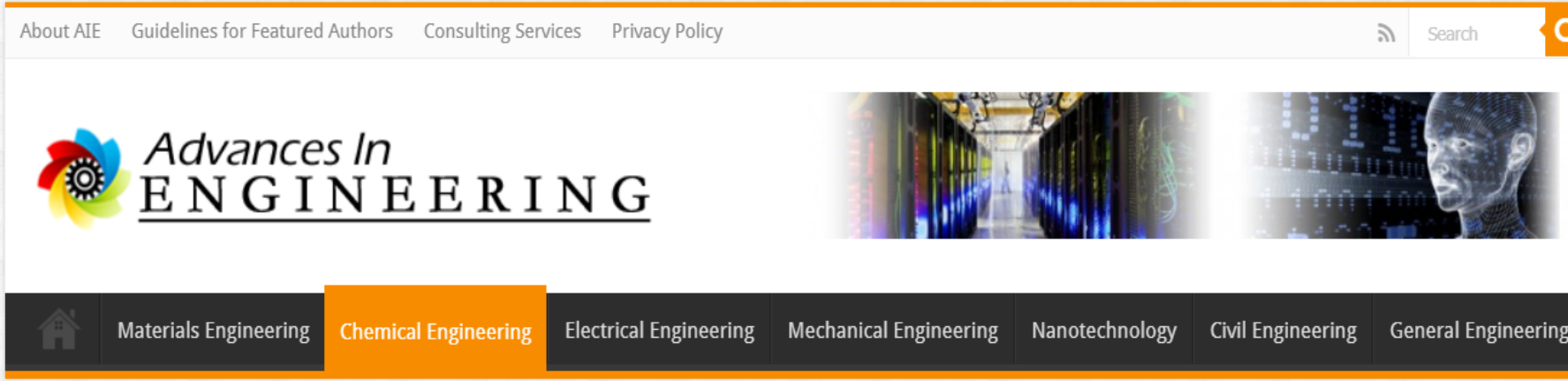
Opportunities

- Replace conventional
- Multi-phase flow
- Extend dynamic range

Threats

- Familiarity with conventional methods

Testimonial



Featured in *Advances in Engineering*; July 2019

Commercialization Plan

- **Option #1:** provide technology to a commercial laboratory
  - Licensing the future IP (i.e. royalty model)

- **Option #2:** build a company around the idea

Who We Are

Christopher R. Clarkson
Professor and the Shell/Encana Chair in Unconventional Gas and Light Oil
Department of Geoscience & Chemical and Petroleum Engineering (University of Calgary)

Tight Oil Consortium (Clarkson's Group):

- 20 industry sponsors & 3 governmental grants
- **One of the largest** in **Western Canada**
- Solves multi-disciplinary problems facing industry in the arena of tight oil reservoirs

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- Shell and Encana
- Sponsors of Tight Oil Consortium: (www.tightoilconsortium.com)
- Puneet Mannan (Innovate Calgary)

Outline

- ❑ Background
- ❑ Problem Statement
- ❑ Solution
- ❑ Proof-of-Concept Results
- ❑ Business Case
- ❑ SWOT Analysis
- ❑ Commercialization Plan
- ❑ Who We Are

Proof-of-Concept Results

❑ Advar

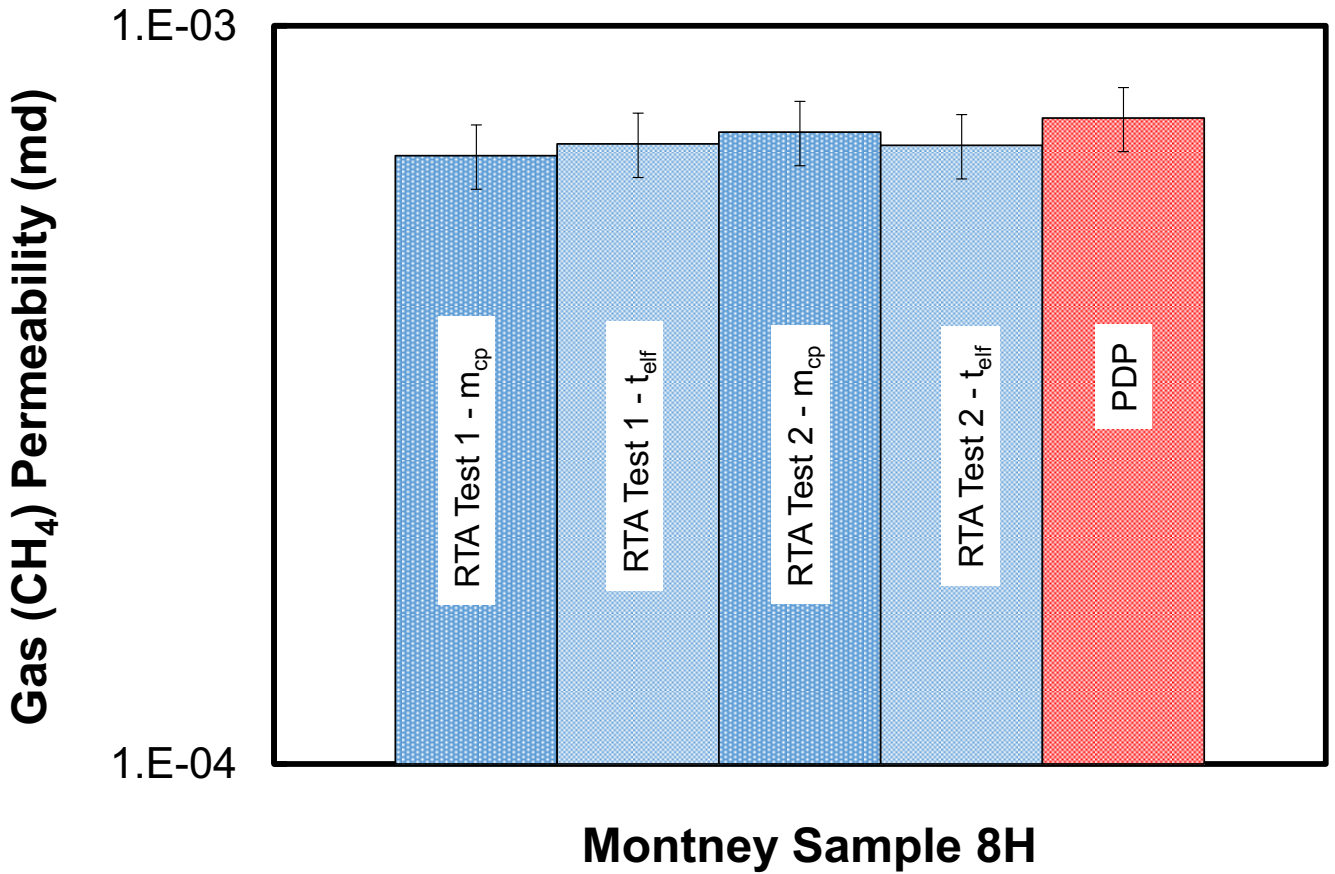
ethods

Test	Volume from liper³ (ft³)
1	12 × 10⁻⁴
2	12 × 10⁻⁴

[1] These are ap
Measureme

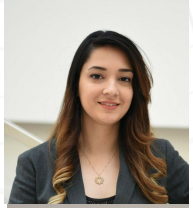
[2] Obtained usi

[3] Obtained usi



Who We Are

Christopher R. Clarkson is a professor and the Shell/Encana Chair in Unconventional Gas and Light Oil research in the Department of Geoscience and an adjunct professor with the Department of Chemical and Petroleum Engineering at the University of Calgary.



Atena Vahedian is a petrophysical assistant at the Tight Oil Consortium at the Department of Geoscience at the University of Calgary with a B.Sc. in Petroleum Engineering (Petroleum University of Technology, Ahvaz, Iran) and is studying MEng. in Petroleum Engineering at the University of Calgary, Calgary, Canada.

Amin Ghanizadeh is a Petrophysical Research Supervisor and Laboratory Manager at the Tight Oil Consortium at the Department of Geoscience at the University of Calgary. Amin has more than 10 years worldwide working experience in Iran, Australia, Germany and Canada.

Chengyao(Charles) Song is a Petrophysical Assistant at the Tight Oil Consortium at the Department of Geoscience at the University of Calgary. He holds a B.Sc. degree in Petroleum Engineering from China University of Petroleum-Beijing, China in 2010, and M.Sc in Petroleum Systems Engineering from University of Regina, Canada in 2013.

Possible Questions

- ❑ Have you already approached commercial laboratories for implementing this? Why hasn't it worked out yet?
  - There is always a lag time between development of new technologies and their adaptation by service companies, particularly in oil/gas industry
  - Patent-pending status might be a reason that the service companies have not made a call on this yet
  - We still have not got a chance to fully present this idea to higher-level decision-making R&D technical teams in various service companies - we just have approached two of the largest services companies so far (CoreLab®, (former) Weatherford).
- ❑ What is the **minimum** capital that you need to start your own company based on this idea?
  - Our preference would be to go with a spin-off model, minimizing the risk
    - Paying the university a royalty on each job/test in expense of using the available infrastructure (lab space, utilities, etc)
    - Assuming to start with 5 RTAPK devices; each $120K (core holder, software, etc) – Total would be $600K (note we can use the same setups to collect gas PDP data as comparative datasets; we can offer the later additional datasets (PDP) at half price or even less to the clients at the beginning of the business for further marketing and advertisement (before the technique is well-accepted by the industry)
    - Initial investment, administrative works, etc: $100K
      - **Total**: **$700K** (Chris: just a very rough estimation)
- ❑ When are you able to start with your own company if you have the capital now?
    - 4-6 months after having the capital (this is mainly the waiting time to acquire the new core holders; made by CoreLab®)
- ❑ How we (the panelists) can help you with this?
  - Providing **right contact(s)** to pitch this idea to in an exchange of a **royalty fee (negotiable)** for a **limited** time period, **depending** on the success of the pitch
  - Providing the capital in exchange of an **equity stake (negotiable)** or **royalty fee (negotiable)** for **limited** or **unlimited** time period – Chris: We may want to think about it at some point how much equity stake or royalty we're willing to give away if an entity is ready to hand in the capital tomorrow ☺