Introduction

Unconventional Reservoir Engineering from our perspective

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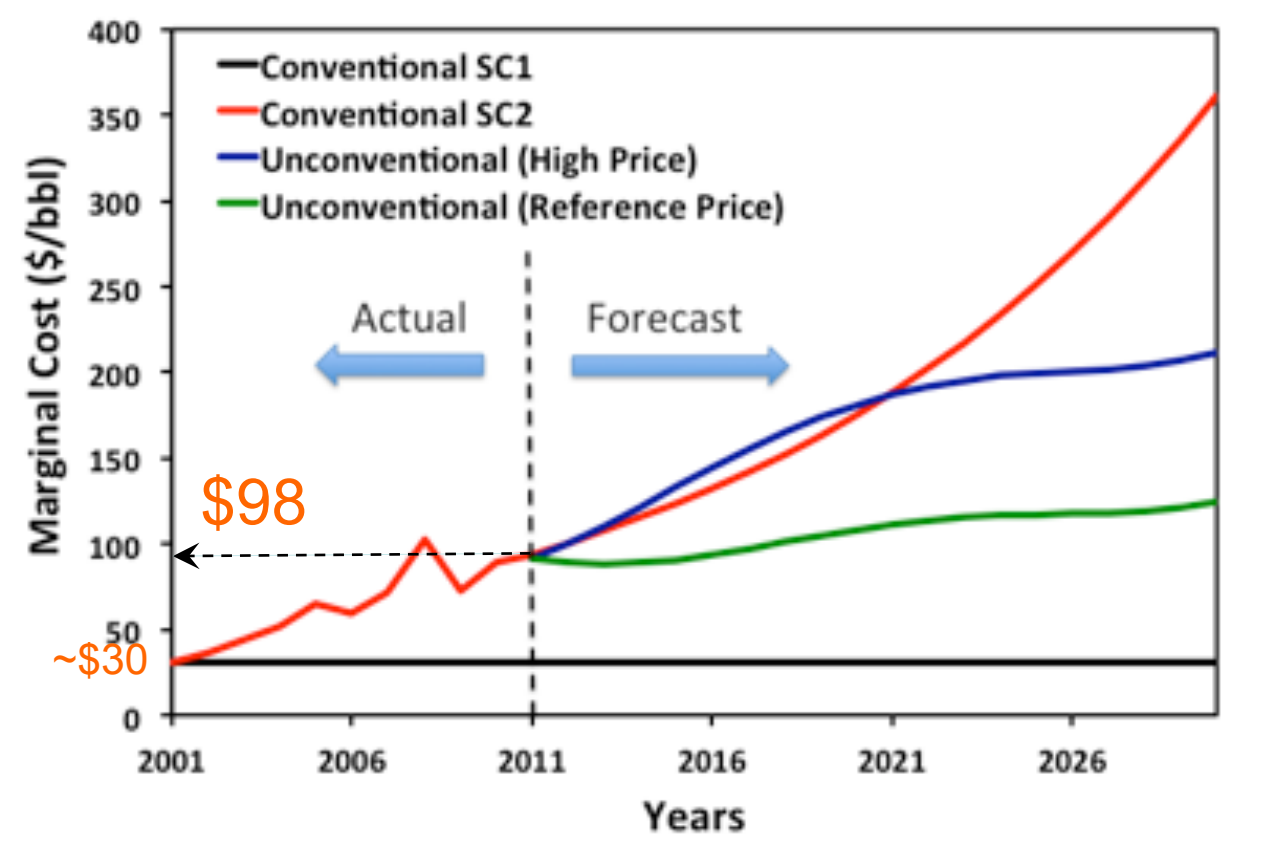
UREP Motivations

Marginal Cost of Conventional Resource Substitution

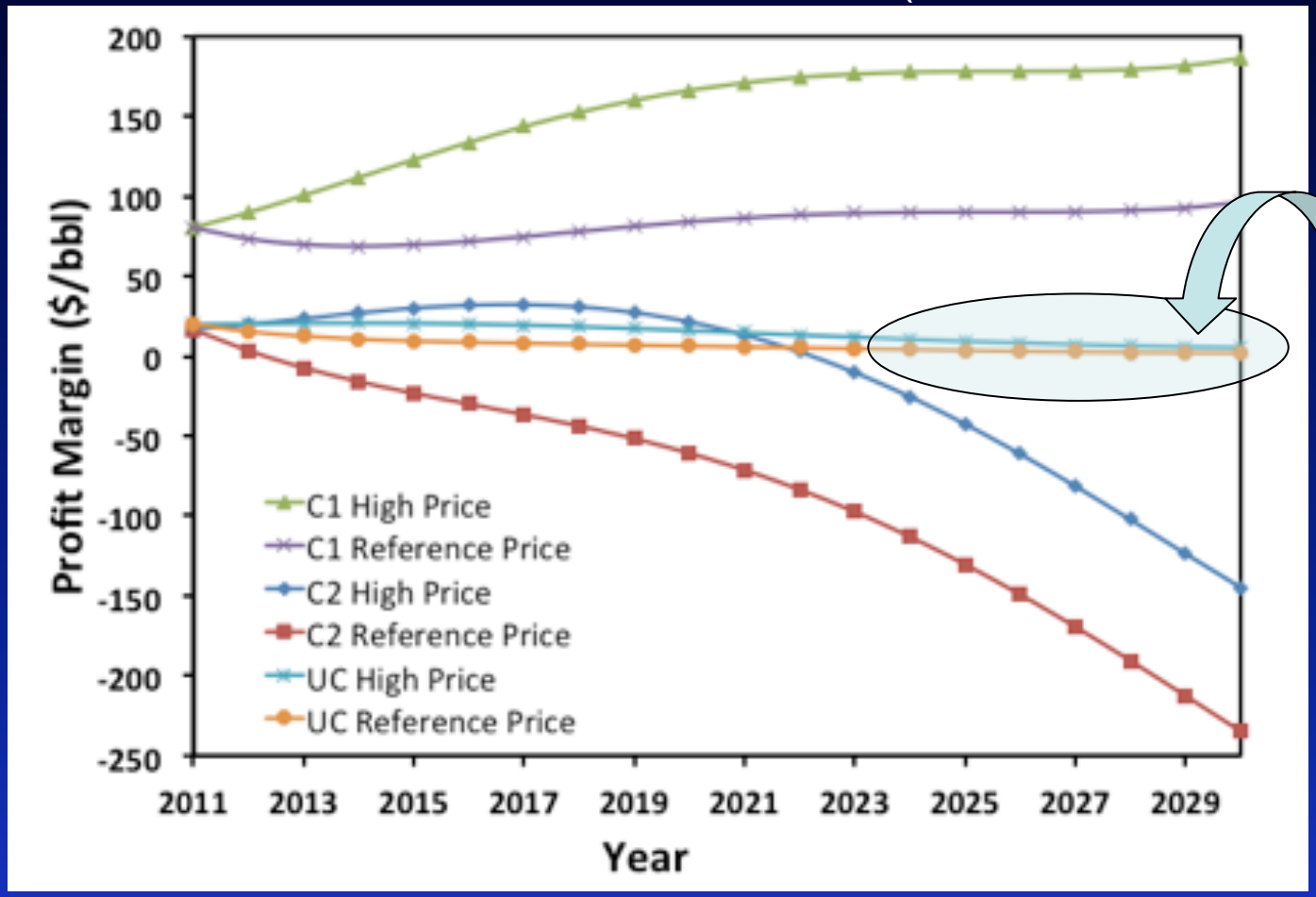
(Ozkan et al. Oct. 2012)



UREP Motivations

Profit Margins by Resource and Price Scenario

(Ozkan et al. Oct. 2012)



Can the industry operate with this kind of profit margin?

UREP Motivations

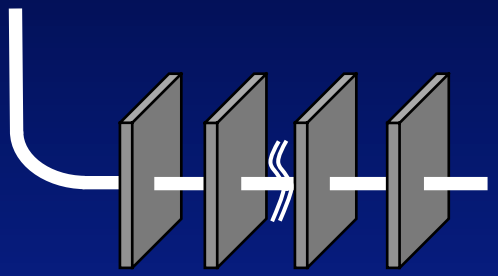
To stay in the positive profit margin, resource substitution by unconventionals is a must

Despite all the hype about unconventional reservoirs, profit margin of producing oil from ultra-tight formations is only a few dollars

Price being fundamentally an exogenous variable, the only viable solution is to reduce the cost of exploration and production by R&D

Unconventional Reservoir “Revolution”

The development of tight unconventional resources is a result of the technological advances in tools and implementations



10,000-ft horizontal well with
40 stages of fractures

However, our understanding of the physical mechanisms of fluid production from these reservoirs has been limited

Unconventional Reservoir “Revolution”

Initially, the industry conceived the unconventional-reservoir-engineering as an issue of

- using conventional concepts with nano-scale reservoir properties
- and incorporating multiple hydraulic fractures into flow models.

This approach became inadequate as the long-term reservoir-management concerns offset the initial hype about unconventional reservoirs.

Consequently, the interest in genuinely-unconventional reservoir-engineering-research has started growing.

What is an “Unconventional Reservoir?”

We consider reservoirs with

- distinguishing geologic characteristics,
- geochemical characteristics
- petrophysical complexities
- well-completion challenges
- flow-mechanism “oddities”

as unconventional reservoirs

Our particular interest in UREP is nano-pore systems

Flow Mechanism “Oddities”

What we call “oddities” are deviations from our perceptions

Our definition of transport in porous media is phenomenological

Prat, 2010

Conventional reservoir engineering perceptions

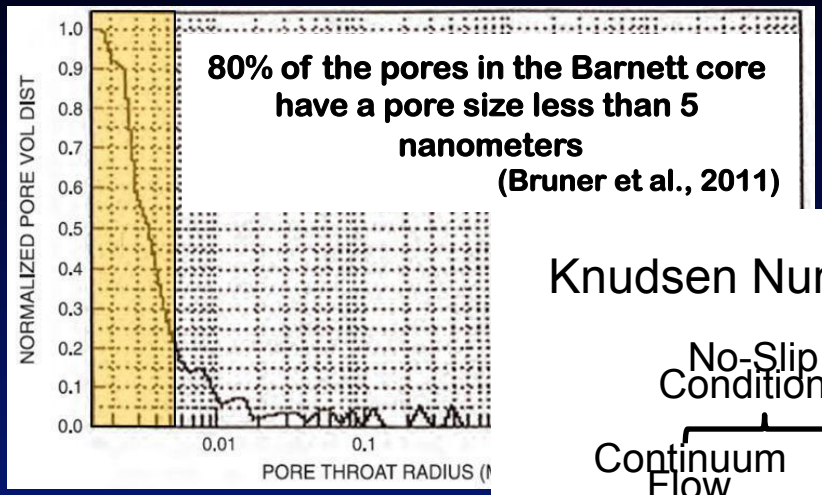
The porous medium is a continuum
Saturation, pressures, etc., are volume-averaged quantities
The relation of fluxes to gradients is through empirical coefficients.

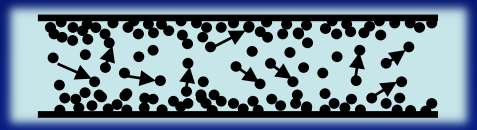
Conventional constitutive relationships of flow in porous media:

Darcy’s law
Relative permeability
Macroscopic capillary pressure, etc.

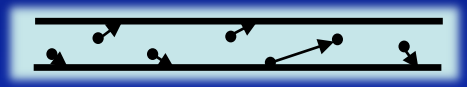
We are set to dispute all our conventional perceptions and build a new understanding with a bottom-up approach

When does the “oddity” becomes the rule



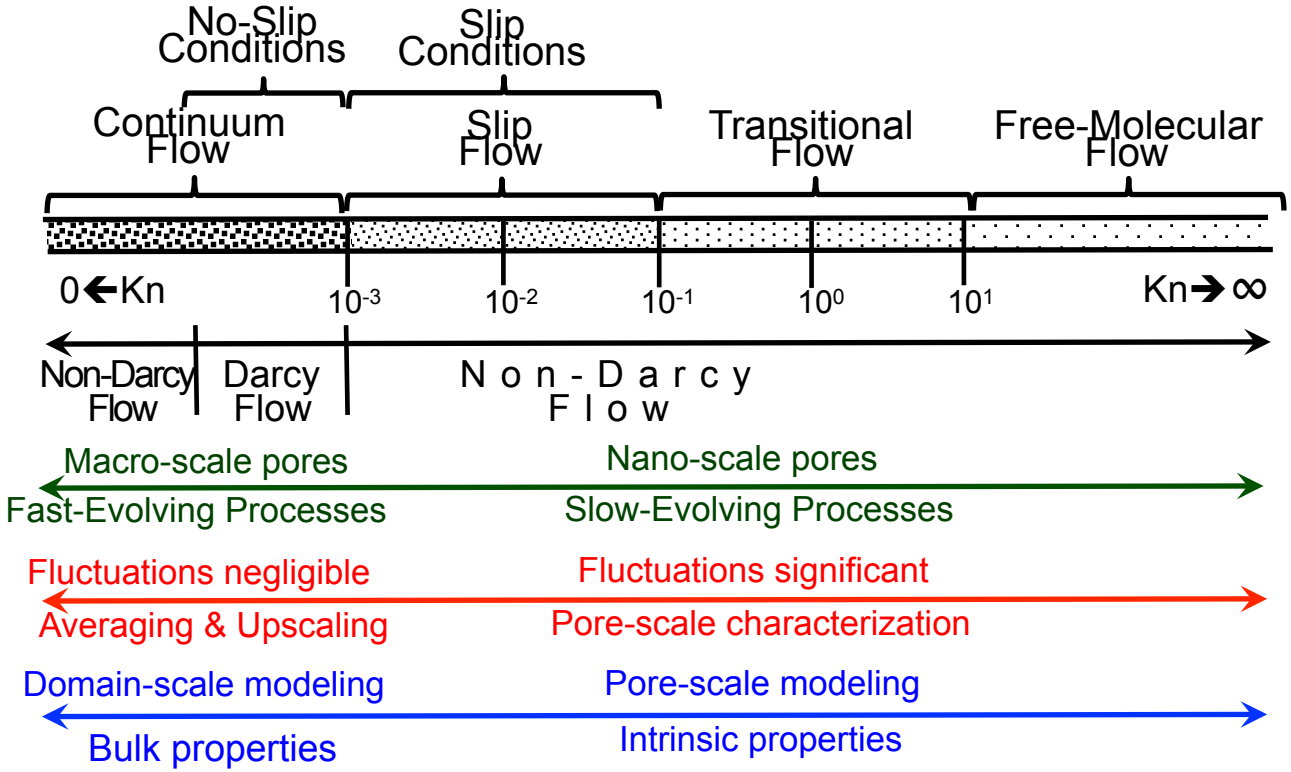


Darcy Flow
(No-Slip Flow)



Gas-Flow in Nanopores
(Slip Flow)

Knudsen Number: $Kn = \frac{\lambda}{\Lambda} = \frac{\text{Mean Free Path of Fluid Molecules}}{\text{Macroscopic-Average Pore-Diameter}}$



Modify or Rebuild?

Three approaches to unconventional reservoir engineering

1. Scale change without change of perceptions and constitutive relations

2. Scale and perception change, but the same constitutive relations

3. Change of scale, perception, and constitutive relations

UREP - Objectives

The objective of UREP is to

attain a more complete reservoir engineering understanding

and develop more appropriate reservoir engineering tools and practices

for tight unconventional oil and natural gas reservoirs.

UREP - Focus

The focus of UREP is

- the discerning physical characteristics of nano-pore, micro-fractured formations,
- unconventional flow mechanisms and unaccounted capillary and surface-forces relationships in extremely small (nano-meter size) confinement
- unaccustomed multi-phase flow concepts and constitutive relations
- new fluid exchange mechanisms between fractures and the tight rock matrix.

UREP - Outcome

The outcome of UREP is the development of

- a physical framework of flow in nano-pore systems
- reservoir characterization at pore-scale
- averaging and upscaling considerations
- new constitutive relations
- unconventional reservoir models
- unconventional reservoir simulator
- analysis techniques
- prediction tools

Membership

The first phase of the Consortium is proposed for two years

The cost of membership is $45,000 per year

($40,000/year for those who join by Dec. 31, 2012)