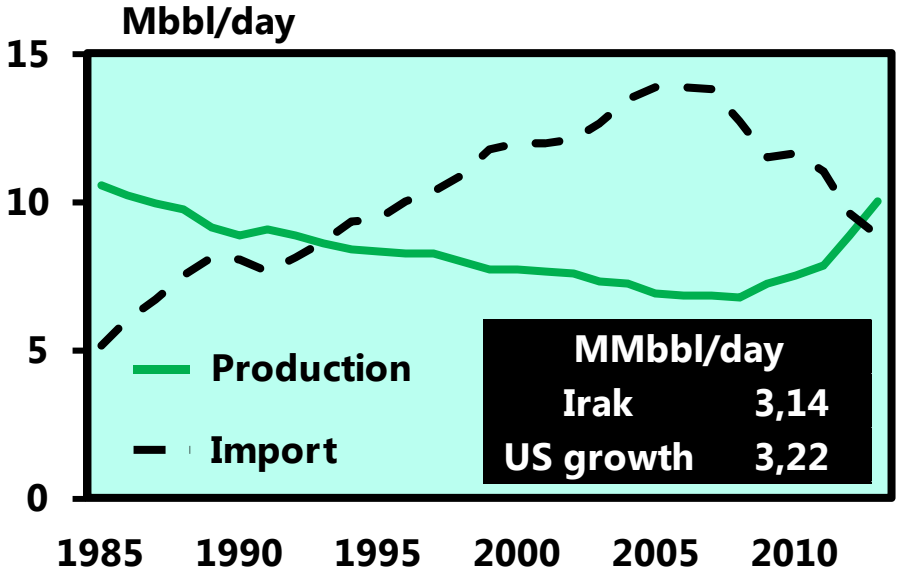
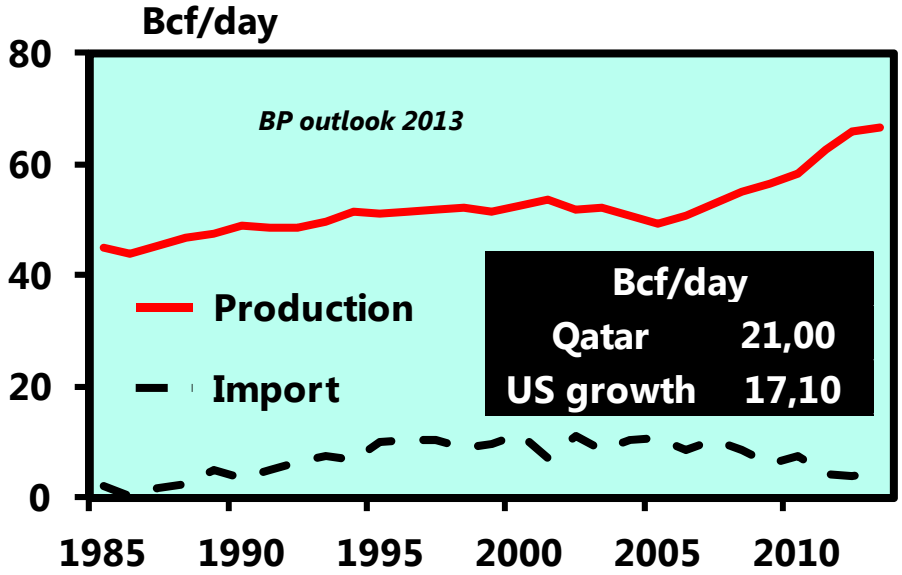
LES PÉTROLE ET GAZ DE SCHISTES. LA GÉOMÉCANIQUE DEVIENT LE « *4ÈME G* » DE L'EXPLORATION PÉTROLIÈRE

By Philippe Charlez - Total

CFMR – 10/10/2014

2006 & 2008 : the start of an oil & gas revolution

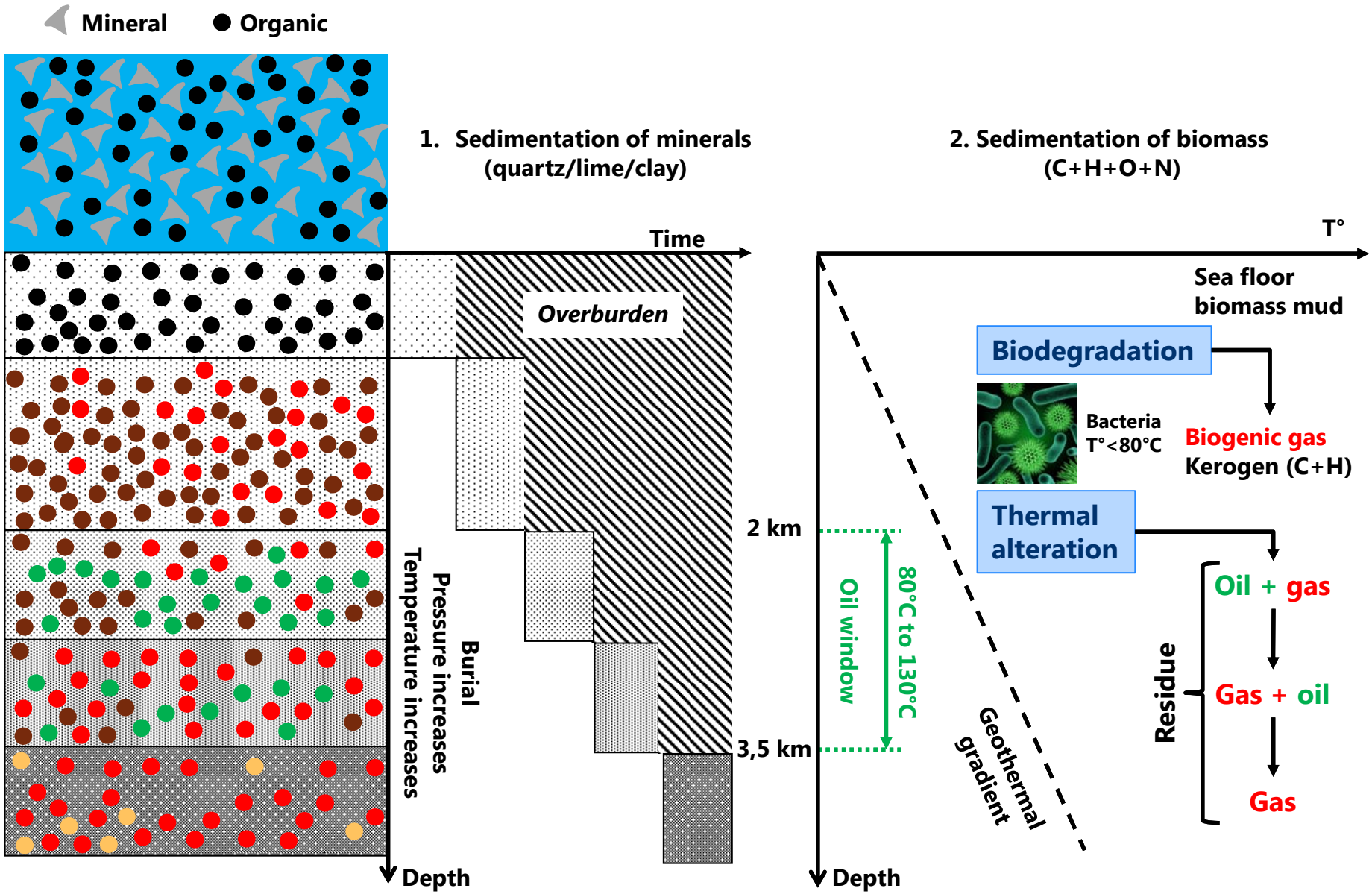




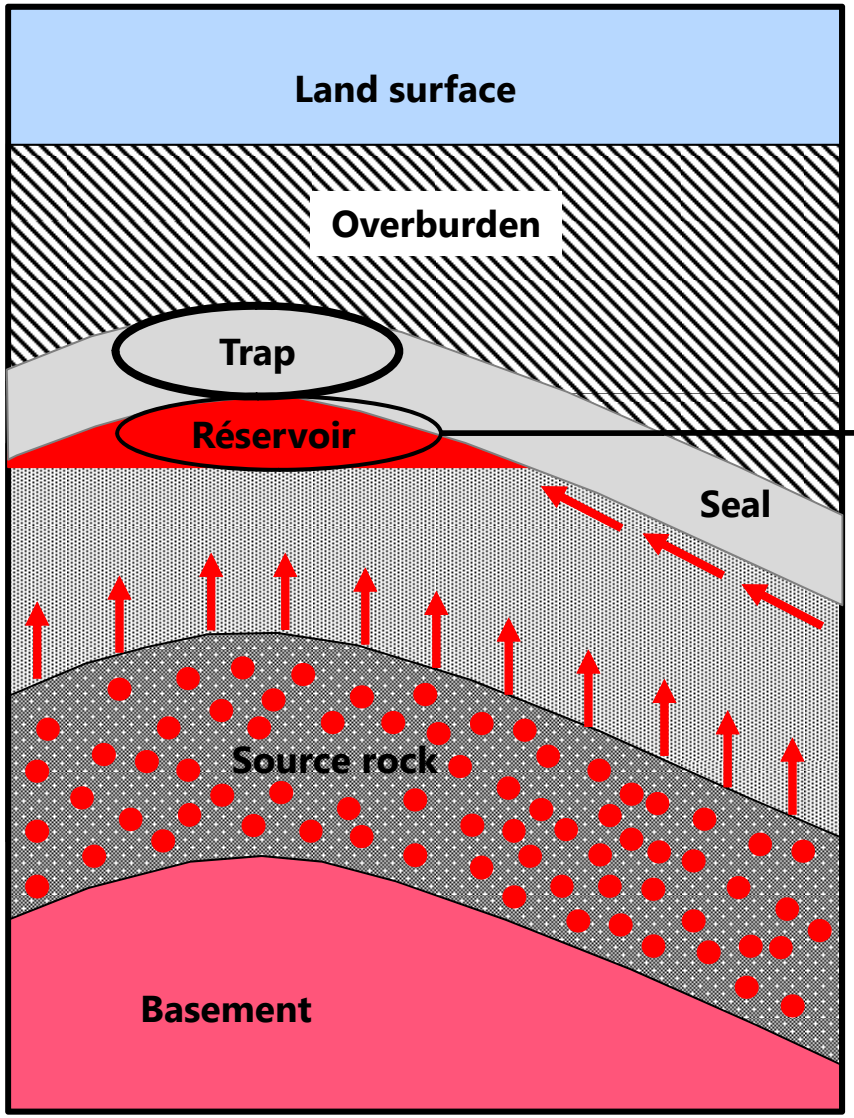
Date	Oil (Mbopd)		Gas (Mboepd)	
	Prod	Import	Prod	Import
2000	7,7	12	8,9	1,9
2006	6,8	14	8,6	1,5
2013	10	8,8	11,3	0,8

- Oil production increases by 38 %
- Oil import decreases by 22 %
- Gas production increases by 30 %
- Gas imports decrease by 92 %

How hydrocarbons are manufactured ?



Oil & gas system : from source rock to reservoir

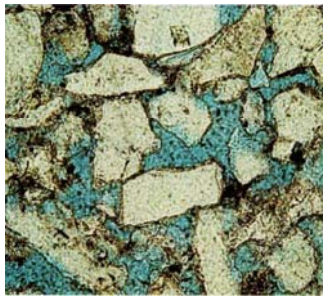


Conventional exploits reservoir

Unconventional exploits source rock

Reservoir

1. Medium to coarse grains,
2. High permeabilities (mD to D)
3. Limited extension (1000 km^2)



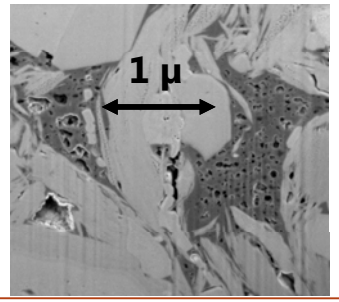
100 µ

Manuturation of HC = Temperature + Time (Myrs)

Time condition = very low permeability

Source rock

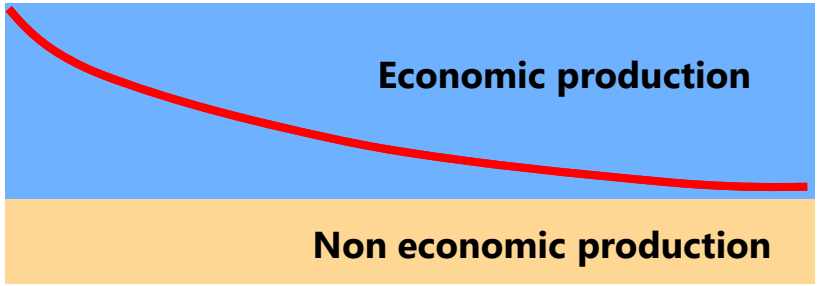
1. Very fine grains
2. Very low permeabilities (nD)
3. Very large extensions



Production of conventional & unconventional

Res. quality

- k *"economic"*

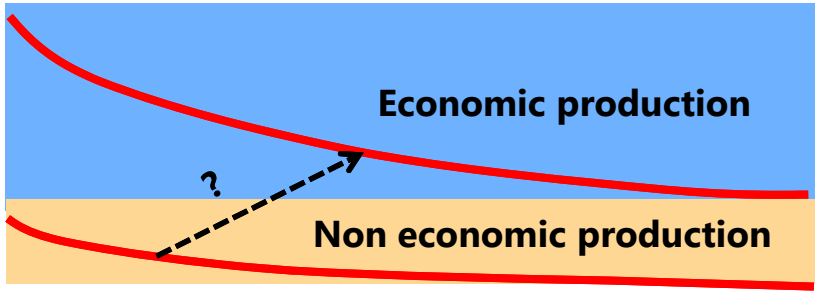


Reserves

Conventional

Play quality

- Mature HC
- k *"uneconomic"*
- Pore pressure



Reserves

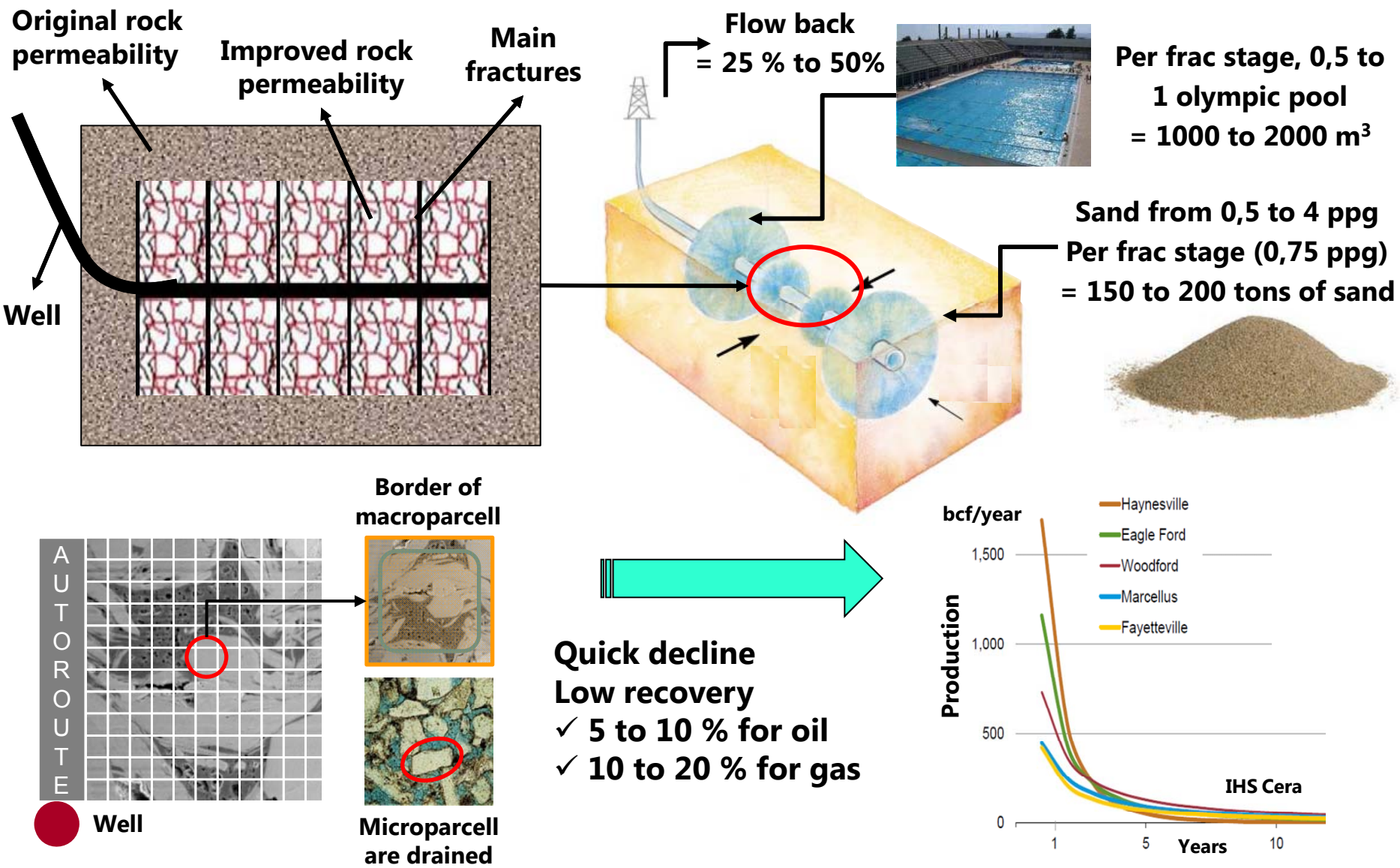
O&GIP

Unconventional

HC in place are not "naturally" transformed in reserves

Economiic permeability to be "manufactured" artificially

Coupling horizontal and HF to build a SRV



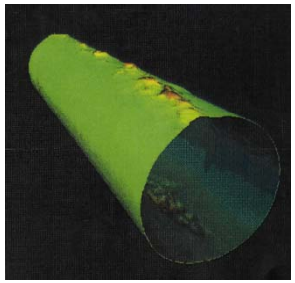
SRV quality

Play quality	SRV quality
➢ Mature HC ➢ Uneconomic k ➢ Pore pressure	➢ Stresses ➢ Natural fractures ➢ Brittleness
Hydrocarbon in place	Reserves ?
3G	4thG

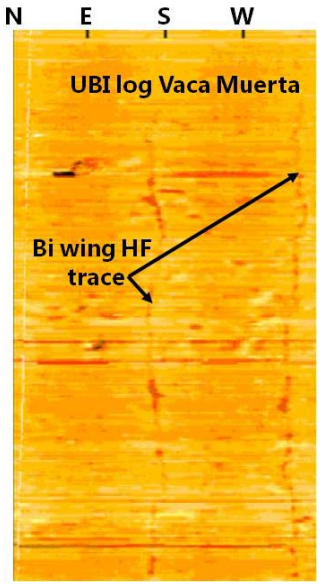
Sweet spots = play quality + SRV quality

Main parameters controlling SRV quality

1. In-situ stresses

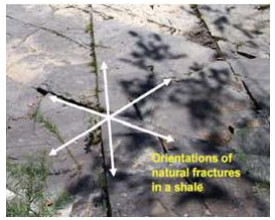


Wellbore breakouts

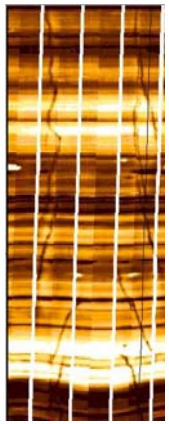


Drilling Induced fractures

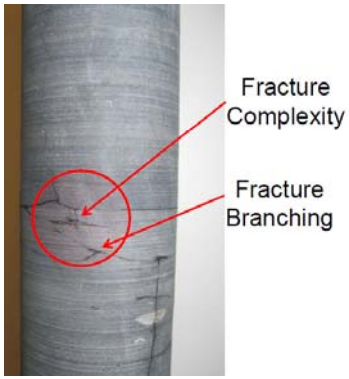
2. Natural fractures



Outcrop analysis

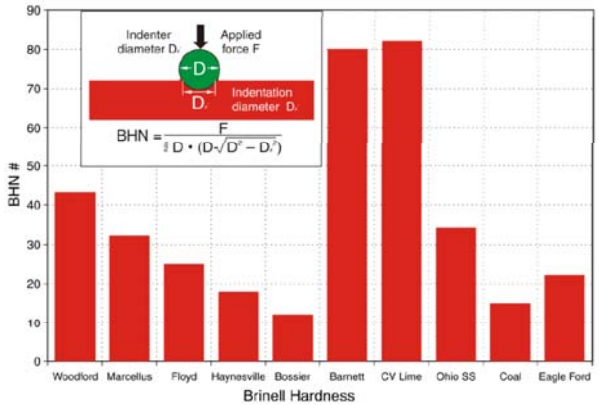


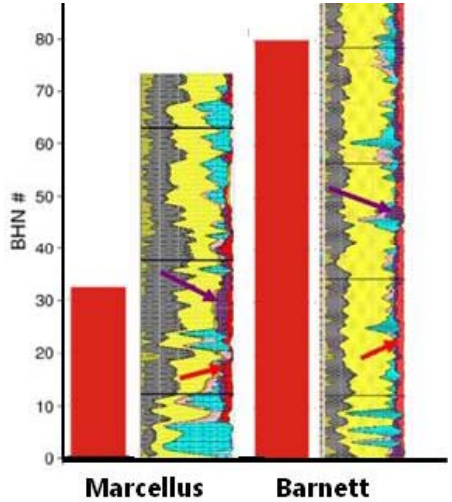
Well imagery



Core analysis

3. Brittleness (mineralogy)





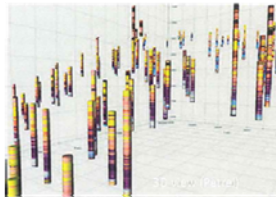
Completion becomes a "geosciences problem"

Sweet spots = play quality + SRV quality

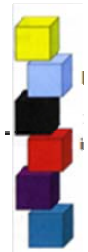
Logs data
Core data

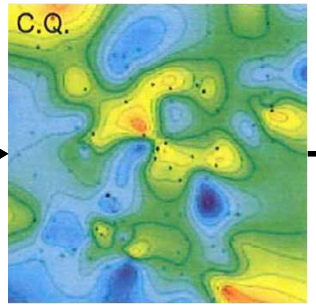
Seismic data

Upscaling

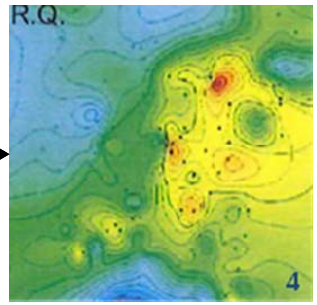


Multivariate & ranking

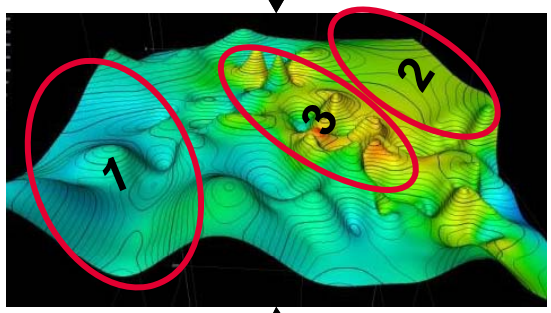




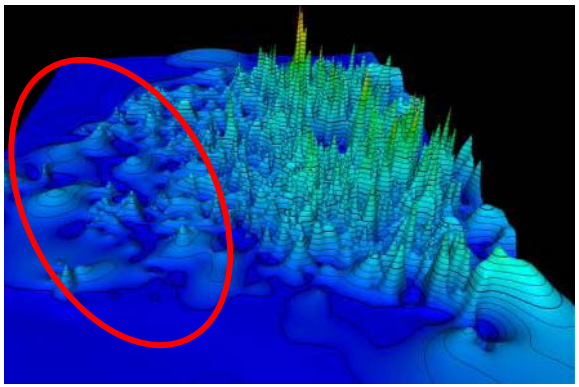
SRV quality



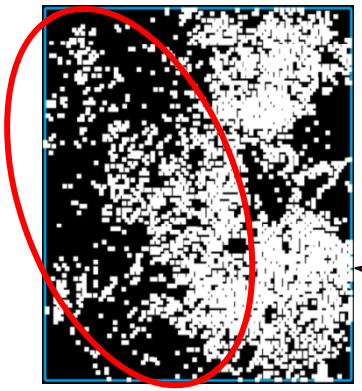
Play quality



1. Low play & SRV
2. High play & low SRV
3. High play & SRV



Unproductive zone

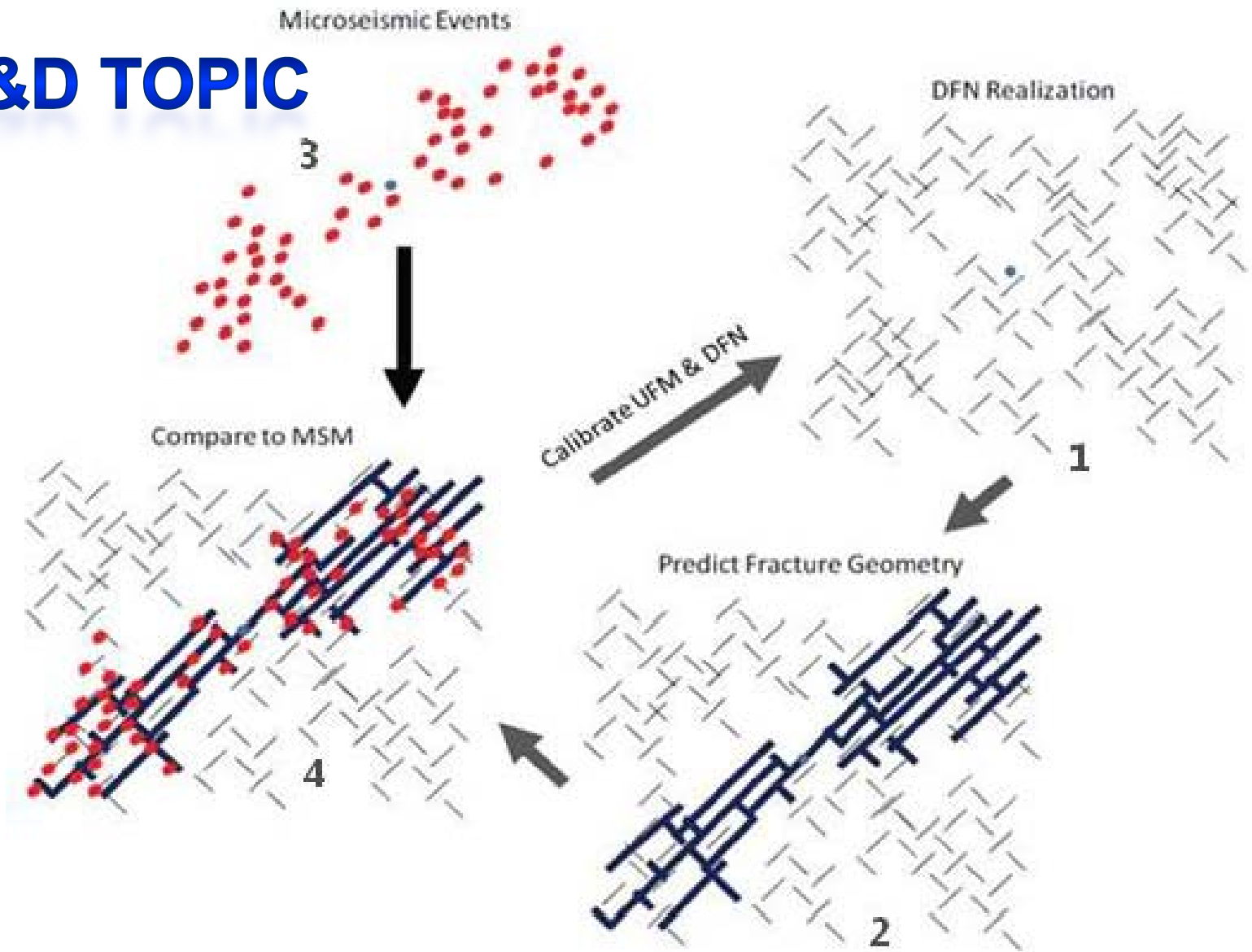


Unproductive wells

Locate sweet spots = minimizing wells
<u>Economical</u> & acceptability challenge

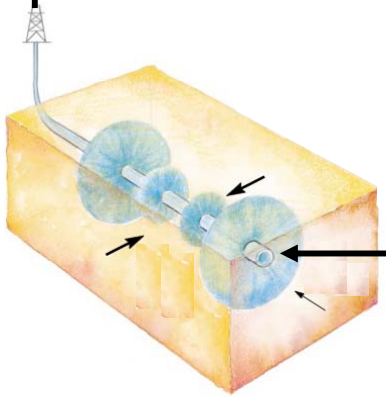
SRV modeling to optimise completion strategy

A R&D TOPIC

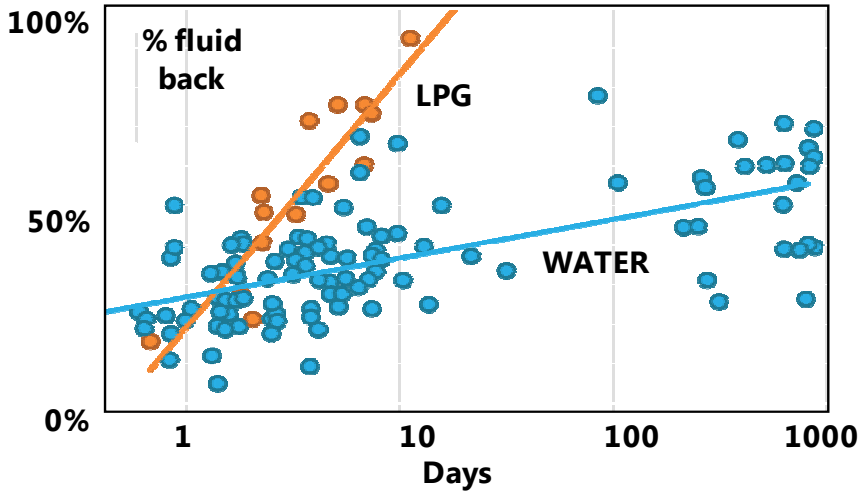


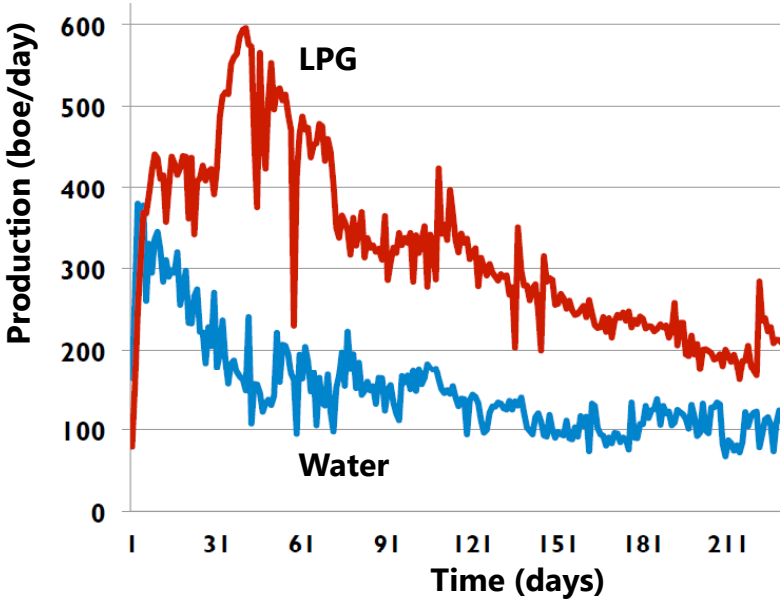
LPG alternative fluids to water

Flow back
= 20 % to 40% of
injected volume



Per frac stage
1 olympic pool
= 2000 m³ of water

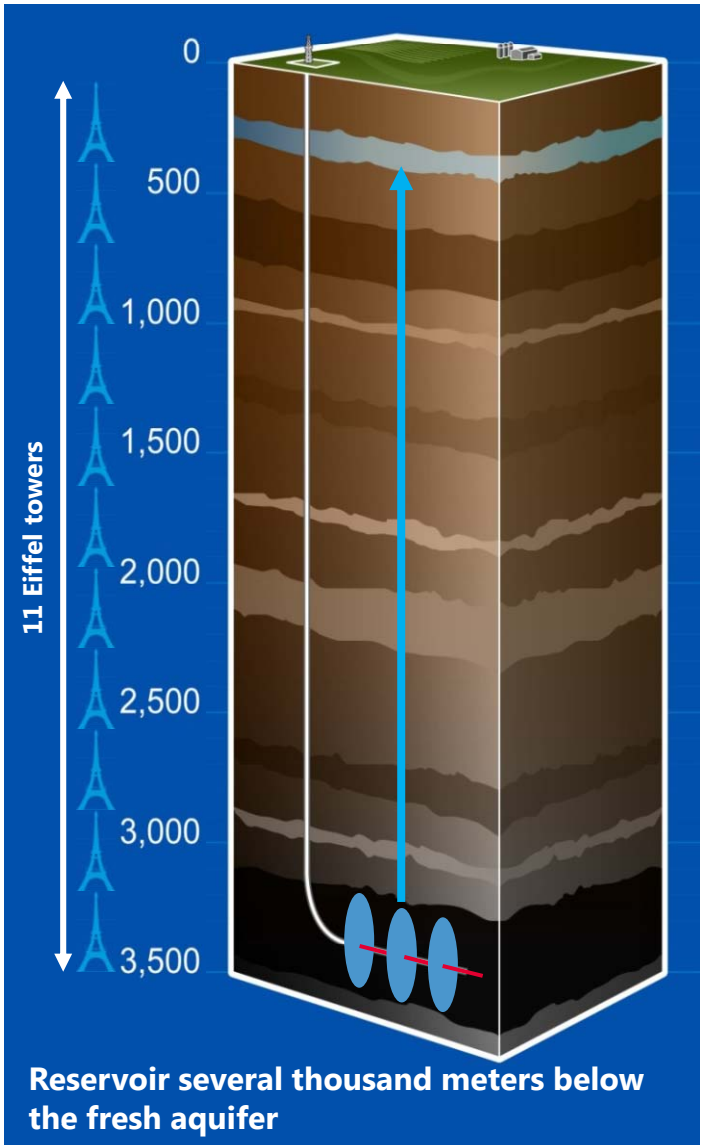


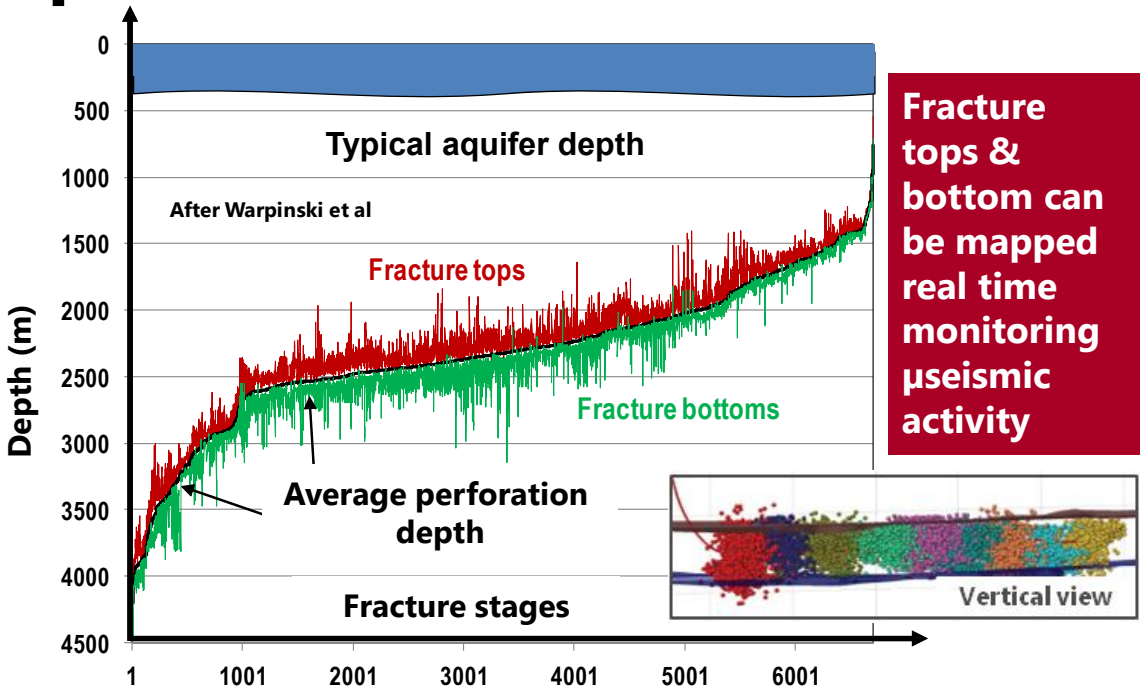


Physical properties	Water	Propane
Viscosity (cps)	0.66	0,08
Specific Gravity	1,02	0,51
Surface Tens (d/cm)	72	7,6
Clay sensitivity	Reactiv	Inert
Corrosion	Yes	No
Bacteria	Yes	No
Scale	Yes	No

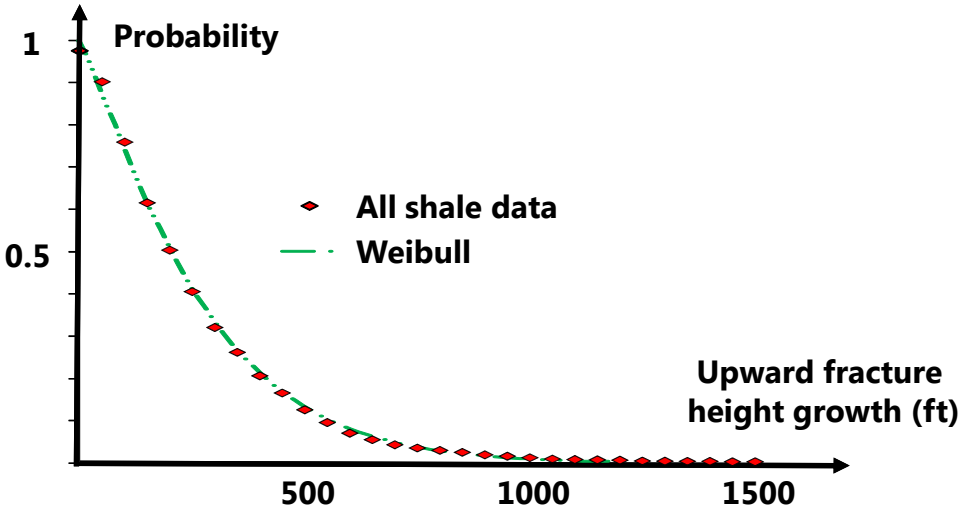
SAFETY issue

Contamination of aquifers





Fracture tops & bottom can be mapped real time monitoring µseismic activity



Conclusion : from source rock to reservoir

From « play »……..to……..reservoir

Rock mechanics transforms the « trial »