

Distinguished Lecturer Program

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Distinguished Lecturer Program
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Formation Damage – Any Time, Any Place, Any Where

Michael Byrne

Senergy

Lecture Outline

- Definition of damage and cost
- When does damage occur?
- At what stage of field development does damage occur?
- Where does damage occur?
- Damage Mechanisms –
Some Examples
- Conclusions – Any time, any place, any where, any how.....

Definition of Damage

- **Formation Damage can be defined as any reduction in near wellbore permeability which is the result of “any stuff we do”**
- **.....such as drilling, completion, production, injection, attempted stimulation or any other well intervention**

What is the impact of damage?

- Shell has estimated that at oil price of less than \$20 / barrel the cost of damage on Shell operated assets was \$1 billion / year.
- Shell, at that time, was producing roughly 3.3 % of total world production.
- \$70 / barrel and global perspective means current best estimate for cost of damage due to deferred production and dealing with damage is \$100,000,000,000 / year

Cost versus Value

- How much does our industry currently spend on understanding and avoiding formation damage?
- Maybe \$100 million?
- Or 0.1 % of the cost!!

When does damage occur?

- Drilling
- Completion
- Attempted Stimulation
- Production
- Well Intervention
- Injection

Damage Risk Assessment

Operation	% of total damage	Impact / removable?(1-5)	Importance
Drilling	25	2	50
Completion	25	3	75
Attempted Stimulation	15	4	60
Production	15	3	45
Well Intervention	10	4	40
Injection	10	2	20

For example: Damage During Attempted Stimulation

- Iron dissolution and precipitation
- Fines Migration
- Asphaltene deposition
- Fracture fluid damage
- Formation Failure
- Sludge

Acid Stimulation

- “There will be dissolution!”
- “There will be precipitation!”
- “Know your reservoir”
 - Dr Hisham Nasr El Din (Texas A&M)
- “Simulate before you stimulate”
 - Computer and laboratory

When is Formation Damage Important?

- **Exploration wells**
- **Appraisal wells**
- **Development wells**

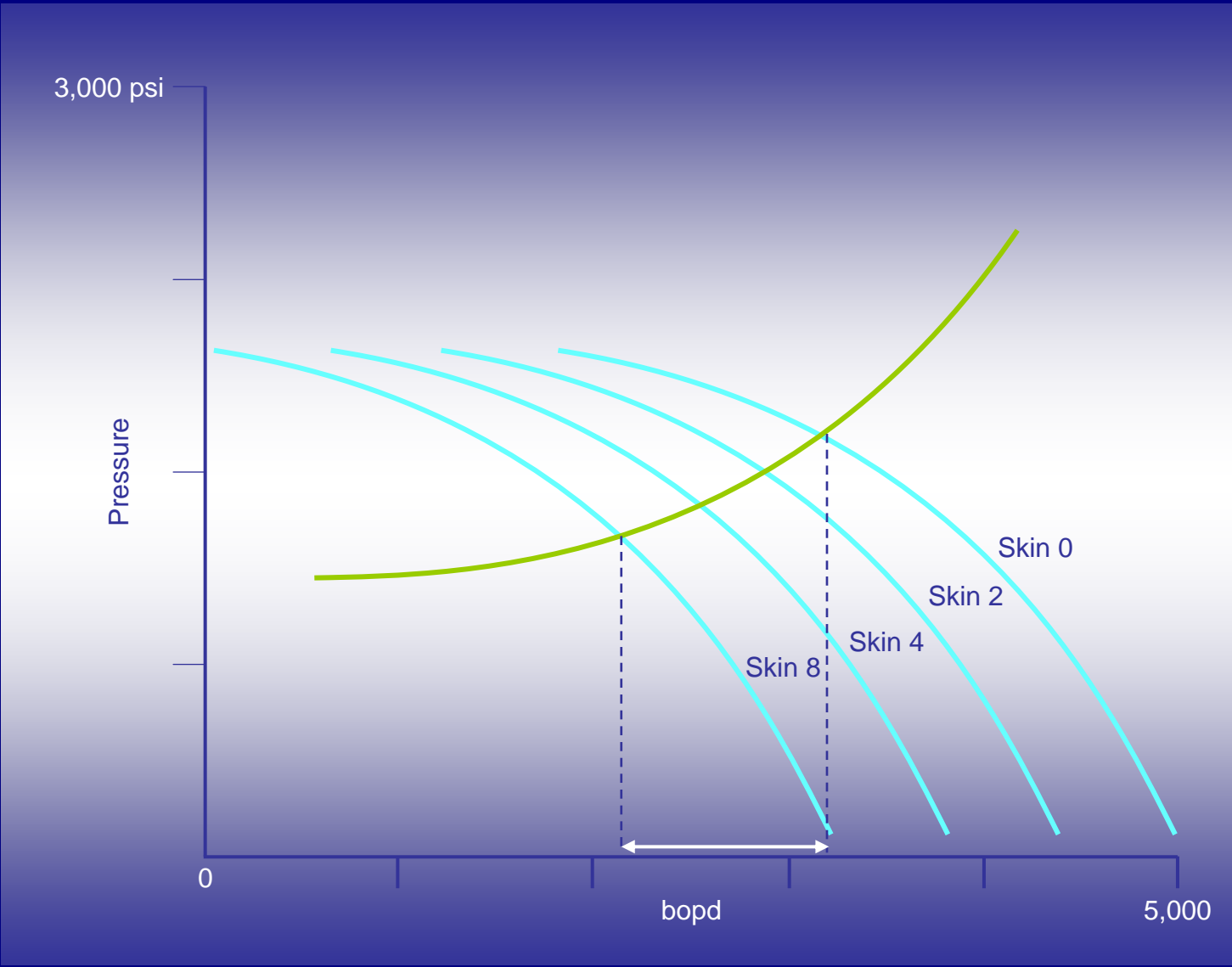
Exploration and appraisal wells

- Undeveloped Discoveries – What if all exploration well test data is tainted by damage?
- Greater Damage in Exploration and Appraisal wells
 - Well objectives
 - Design of fluids
- Prospect Evaluation often ignores damage
- Damage / Productivity potential is the critical factor in many reservoir types from tight gas to friable heavy oil
- Reference SPE 107557, 115690 (Breagh Field)

Damage Mechanisms – Some Examples

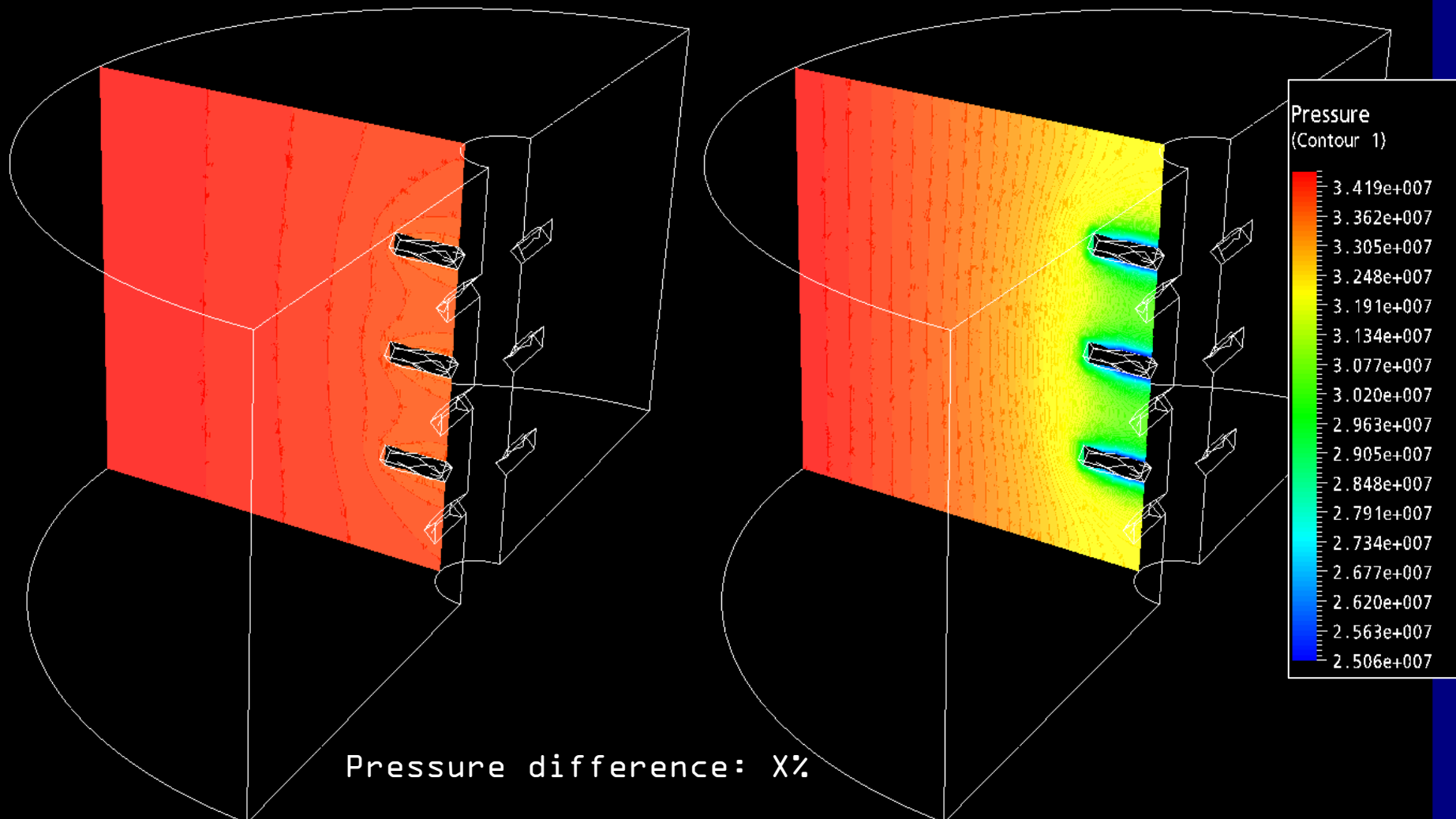
- Example of the impact on well productivity
- Examples from laboratory simulation studies

Formation Damage – Real Impact

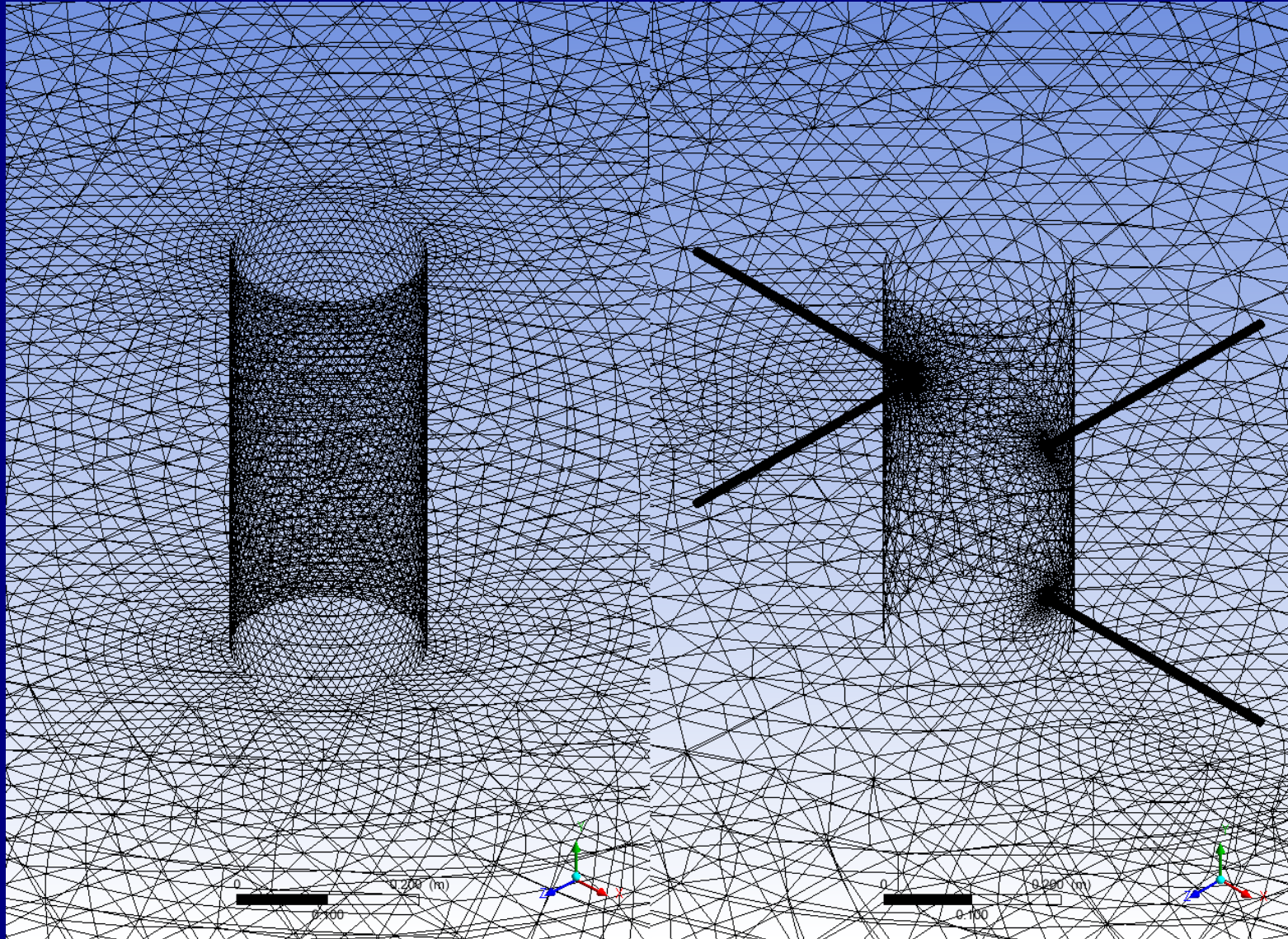


Near wellbore inflow modelling

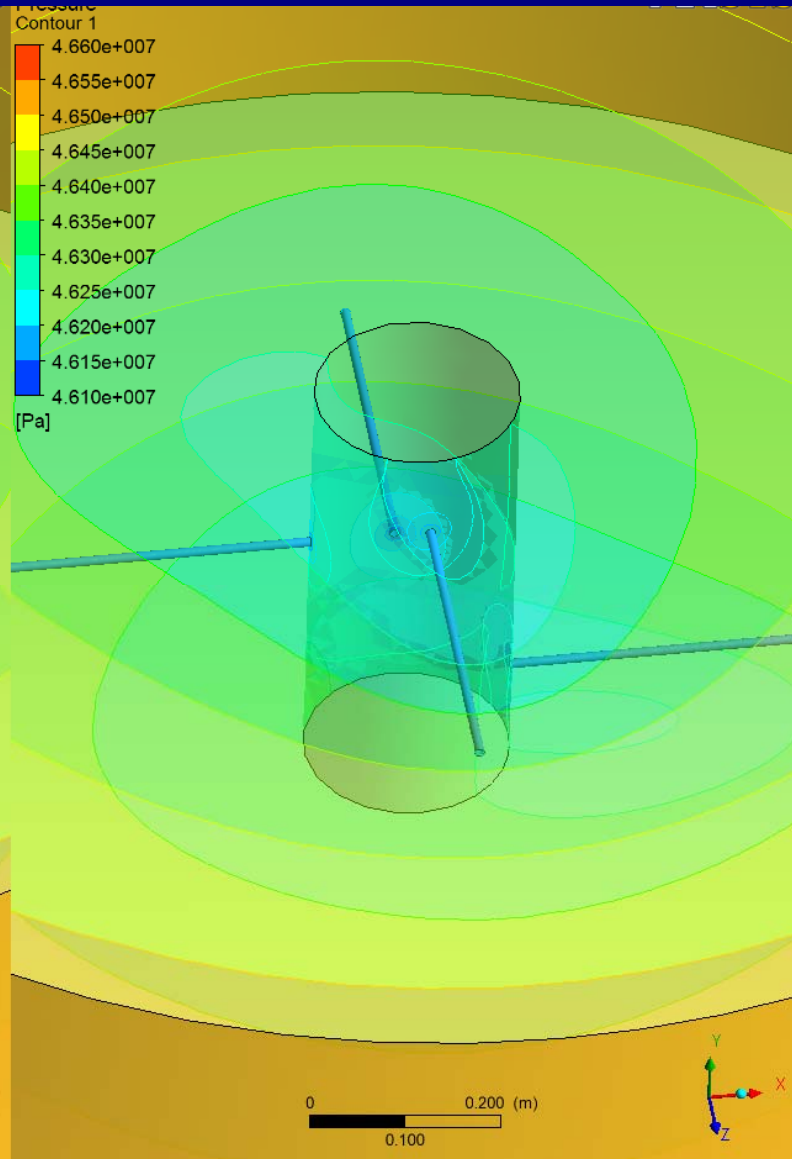
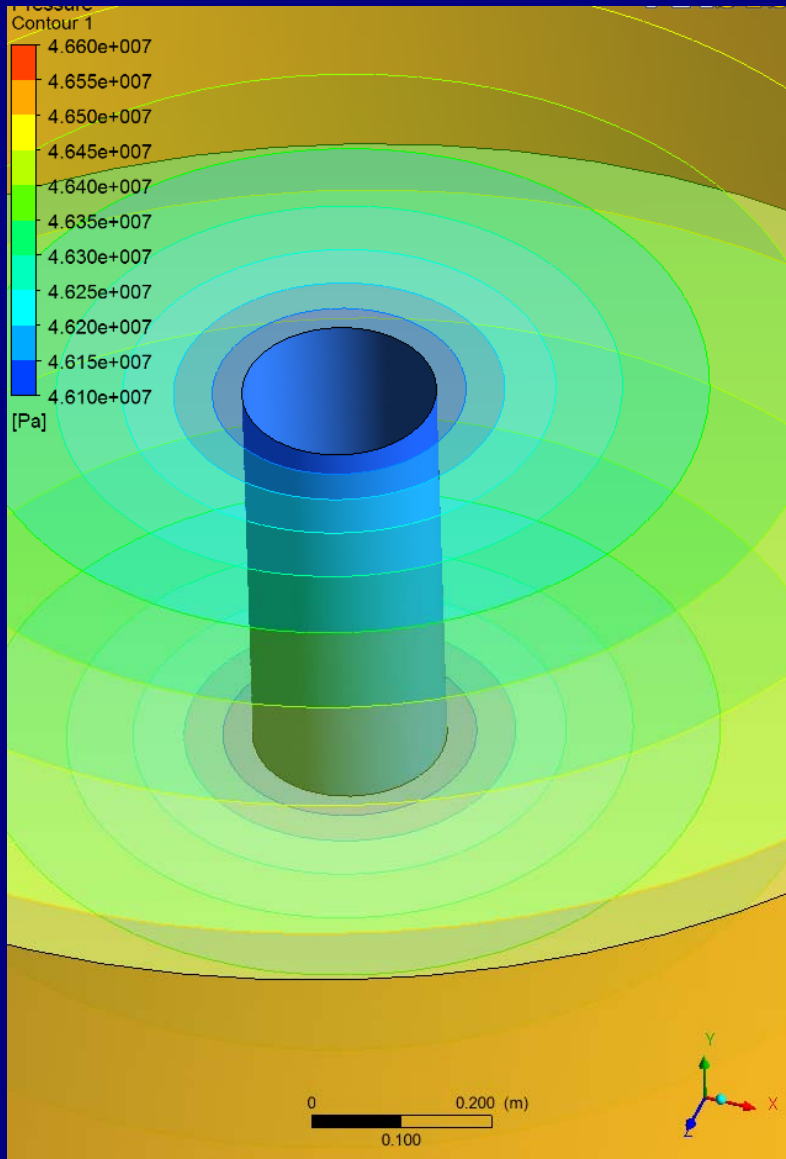
Advances.....



Vertical Open Hole Versus C&P

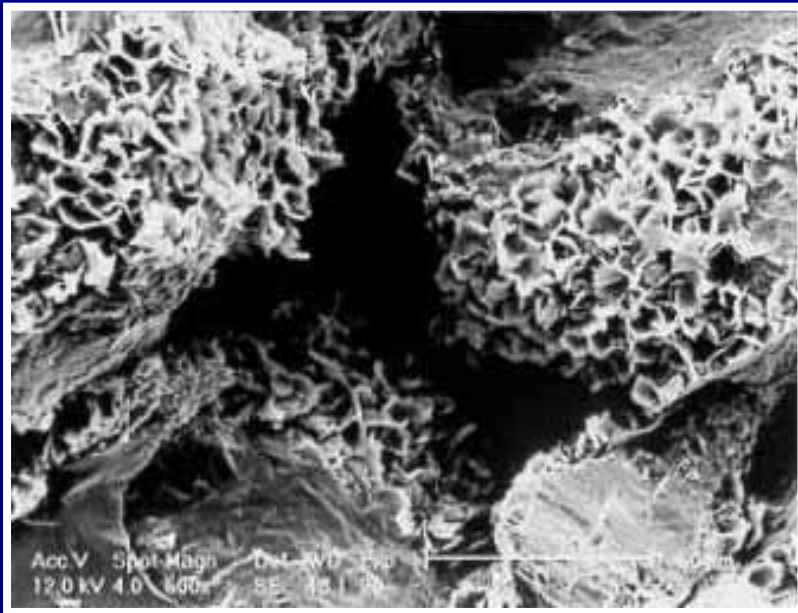


Vertical Well Pressure Profiles

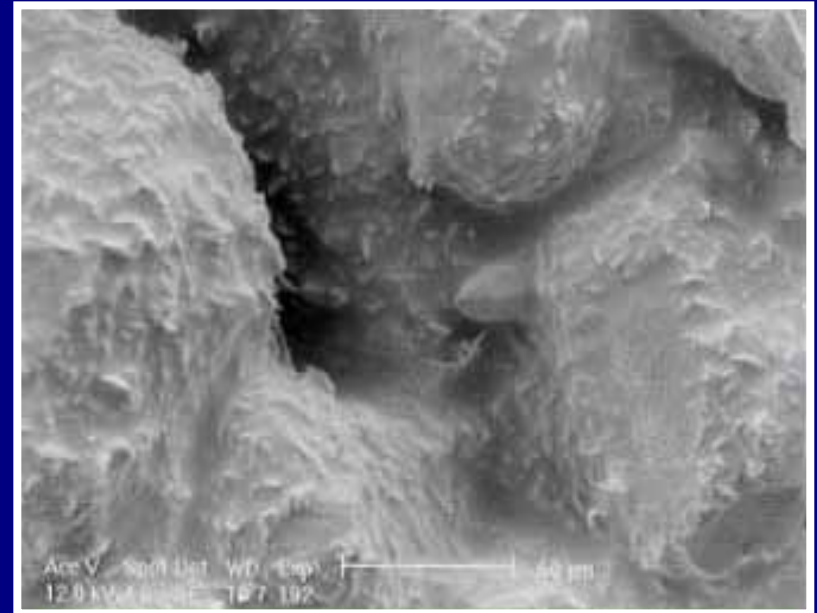


Filtrate Retention – Gas Reservoir

RETAINED MUD FILTRATE LOSSES



BEFORE TEST



AFTER TEST

Fluid has been retained in the micropores between the chlorite platelets

90% reduction in permeability

Solution was to treat with solvent, reduce interfacial tension and release most of the retained fluid – very successful in a laboratory and in the well

Fines Migration Myth or Reality?

- What are fines?
- Clay?
- <44 micron?
- <45 micron?

Fines Migration - Reality

- Fines are.....
- “Any part of a rock that can move through or within the pores of the rock”
- Fines migration is very common, very complex and deserves our care, understanding and attention!
- Solutions to this problem can include reducing near wellbore flow rates, using less damaging fluids or even stabilising fines – see SPE112455

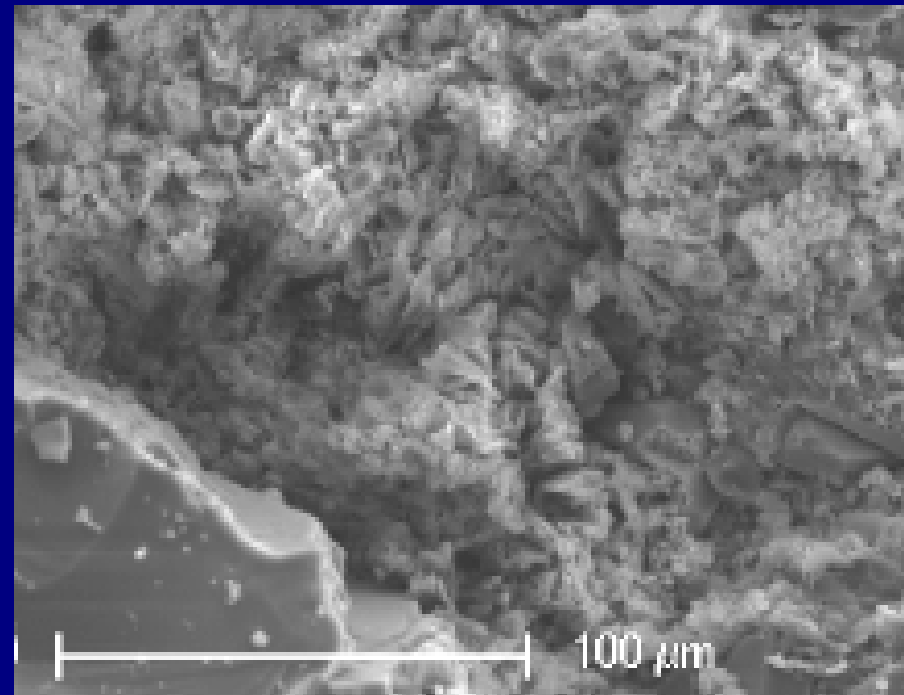
Example of Fines Migration

From SPE 107758 (courtesy of StatoilHydro)

Pre-test



Post-test



Carbonate Reservoirs

- 60% of current proven conventional reserves are located in carbonate reservoirs
- Formation Damage exists in carbonate reservoirs but is different from that in clastic reservoirs
- Consideration needs to be given to design of the wellbore / reservoir conduits interface. This is where damage and stimulation matter most and for carbonates can be difficult to model accurately

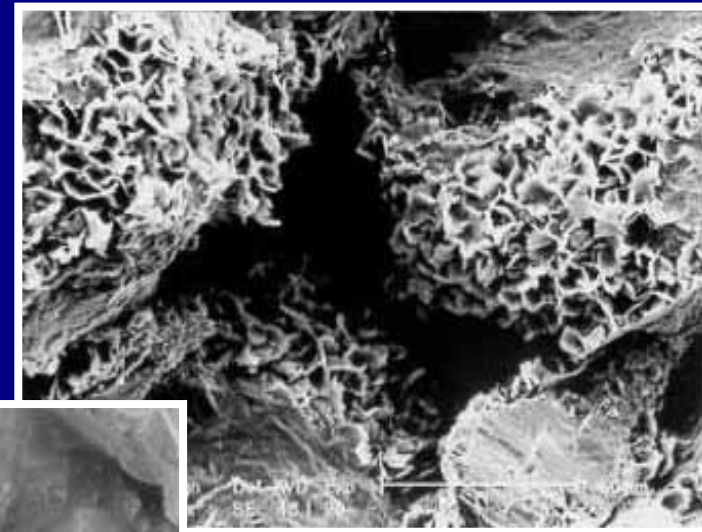
Example of whole mud losses to a fracture system (2mm apertures)



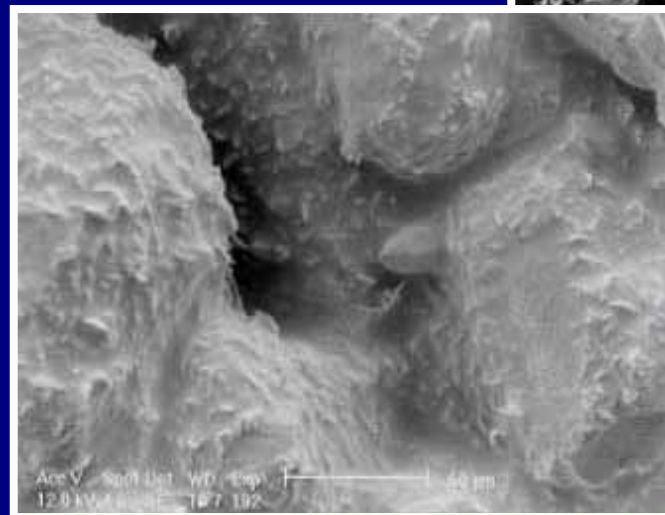
Formation Damage Any Time

- Drilling
- Completion
- Production
- Injection
- Well Intervention
- Stimulation

RETAINED MUD FILTRATE
LOSSES



BEFORE TEST



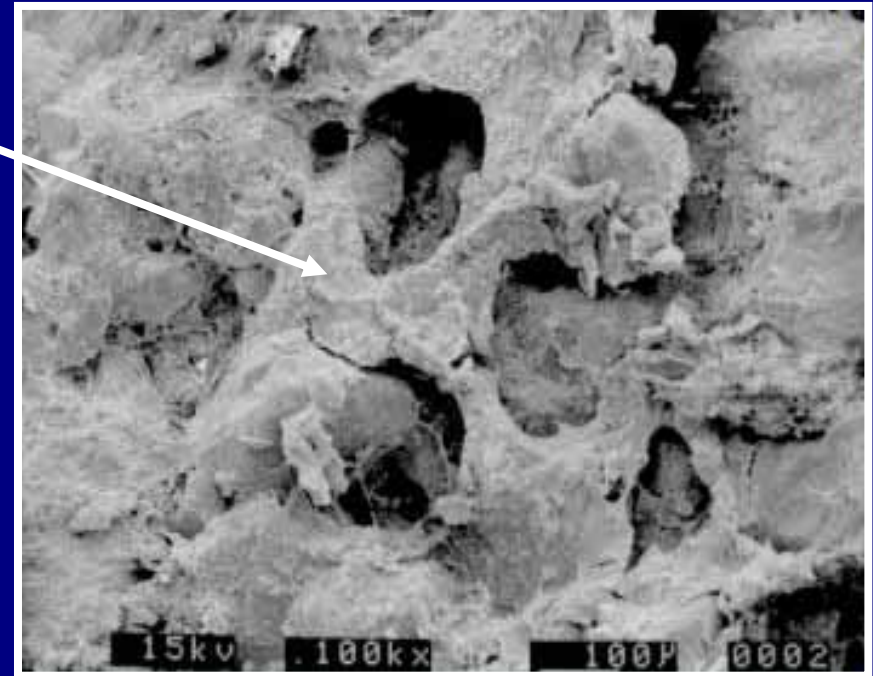
(Photographs courtesy of Corex UK Ltd)

Any Place

- Exploration Wells
- Appraisal Wells
- Production Wells
- Injection Wells
- Well Re-entry, Re-completion

Any Where

- Damage at completion
- Mud cake
- Near Wellbore
- A bit deeper!
- Deep damage



SPE 68969 (Photograph courtesy of Corex UK Ltd)

Any How

- Pore Blocking
 - External – mud cake, particles etc.
 - Internal – introduced solids, fines, fluid retention, etc.
- Chemical
 - Dissolution and precipitation
 - Swelling, wettability etc.

Conclusions

- Formation damage is everywhere
- Understanding impact and mechanisms are the key
- We can minimise most formation damage through understanding

Thank You!

- Formation Damage – Any Time, Any Place, Any where
- Any.....
- Questions??

Distinguished Lecturer Program

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