Geomechanics, a petroleum view

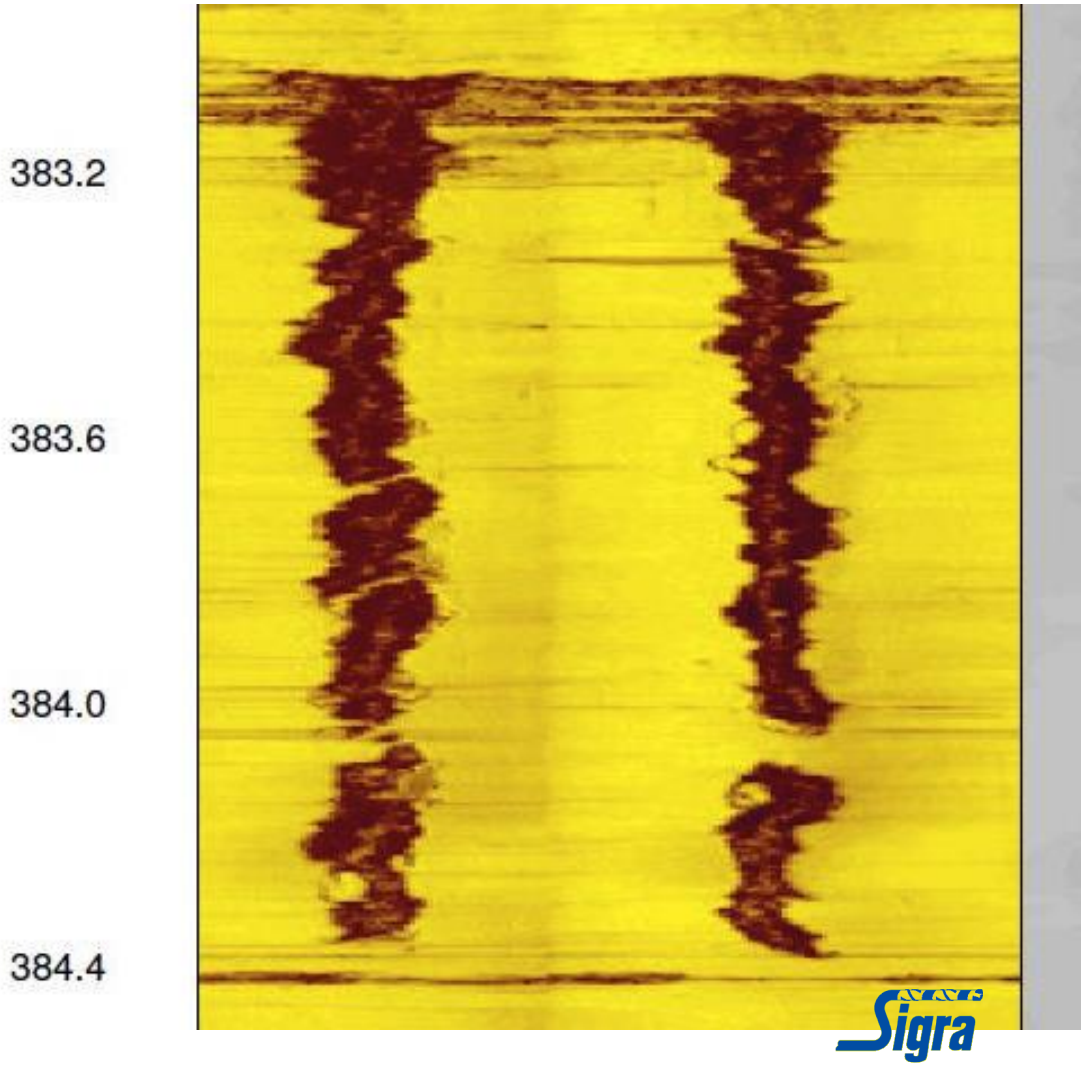
Eurock 2018
22 May 2018
Ian Gray
ian@sigra.com.au
www.sigra.com.au

Primary Considerations

- To be able to drill and keep the hole open
- To be able to hydrofracture to permit stimulation
- Should be
  - to consider the effect of stress changes on permeability – the stress path

Keeping the hole open

- Do stresses lead to hole failure?
- Borehole breakout
- Sand control



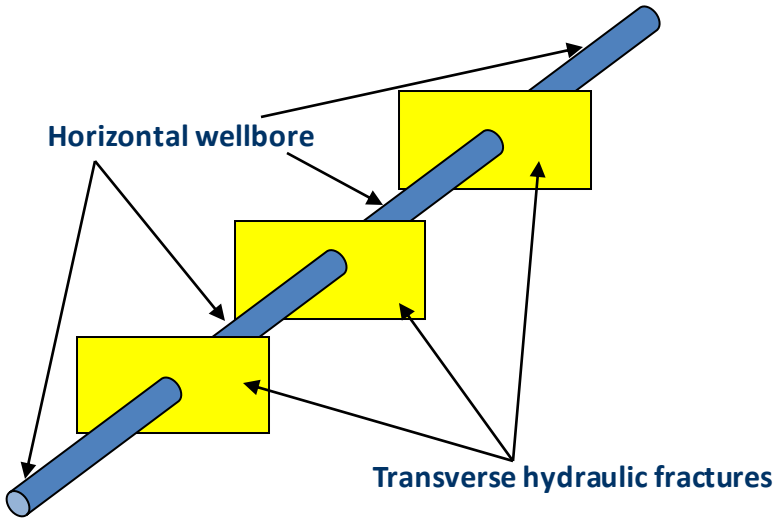
Options to keep the hole open

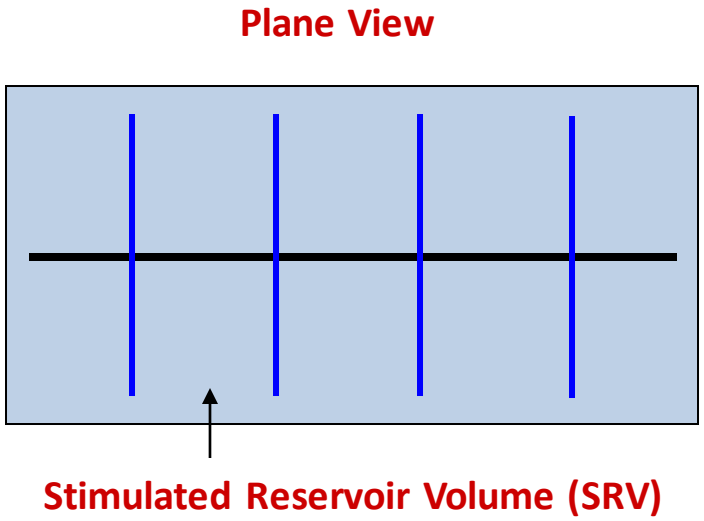
- Use a drilling mud that forms a filter cake on the borehole wall
- Vary mud pressures by density and the use of a choke on surface
- Drill in a favourable direction
  - However this maybe the least favourable for accessing natural permeability
- Once drilled – case the hole with a suitable screen system before it collapses

Hydrofracture

- Hydrofracture will only go in the direction it wants to
  - Controlled by minimum stress
  - Pre-existing natural fractures
  - Is there less resistance to run up pre-existing fractures or to break rock and run in the direction perpendicular to minimum principal stress?

Ideal Concept - Horizontal Wells with Transverse Fractures – This is not a normal fracture initiation orientation from a hole.





Hydrofracture is not a panacea

- Hydrofracture probably goes in the direction least suitable to access the major permeability
- Formation damage can occur due to
  - Fluids that damage the reservoir
  - Stress is applied to the surface of the fracture reducing the permeability
  - This stress may extend deep into the formation when multiple fractures are created.

The importance of stress and stress path

- The dependence of permeability on stress is critical.
- This is much more the case in fractured rocks than in porous ones
- What is this dependence?

$$\log k = \log k_0 - \frac{\Delta \sigma_{eff}}{b}$$

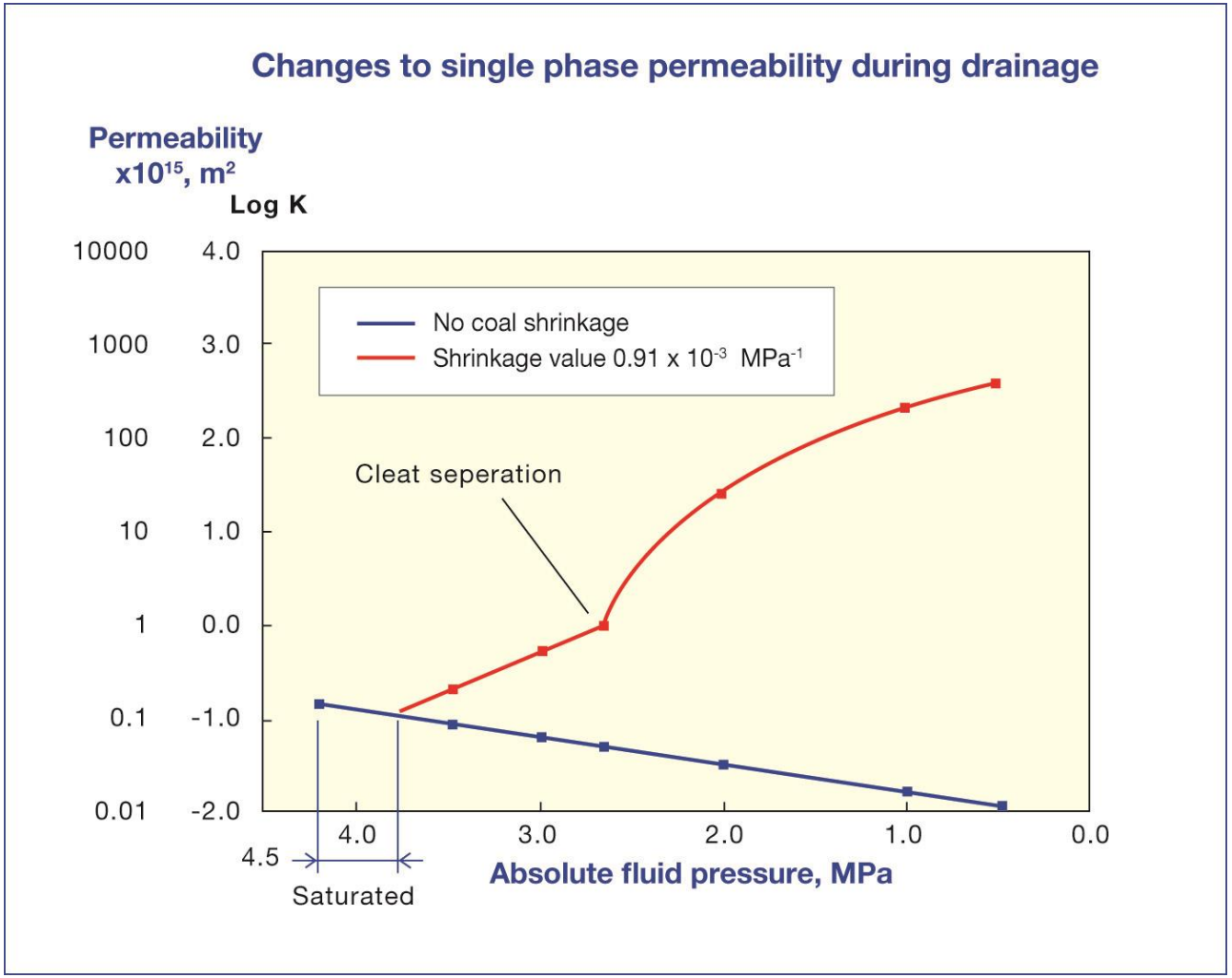
- What is the effective stress?
- What is *b*? One order of magnitude in 3 to 20 MPa?

Stress Path Analysis

- Takes into account
  - Initial state of stress
  - Effects on effective stress of
    - Fluid withdrawal
    - Shrinkage
    - Gas content + Isotherm= Sorption pressure
    - Poroelastic behaviour or fracture elasticity
- Leads to permeability change estimate
  - Or at least a permeability change sign

Sigra

An Extreme Example Of Permeability Change



Thank You

Sigra Pty Ltd

93 Colebard St West, Acacia Ridge, Brisbane Queensland 4110, Australia

Tel: +61 (7) 3216 6344 Fax: +61 (7) 3216 6988 http://www.sigra.com.au