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# Horizontal stress rotation due to reservoir depletion.

HAMID, O., SANAEE, R. and OLUYEMI, G.

2021

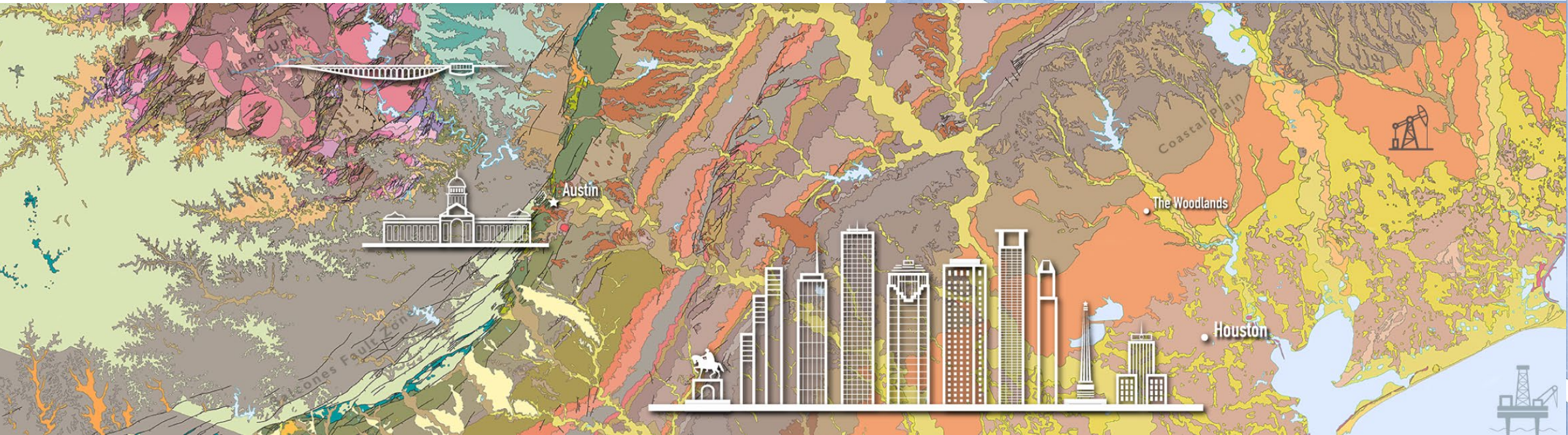
# Horizontal Stress Rotation Due To Reservoir Depletion

ARMA 21-1748

Osman Hamid  
RGU/Saudi Aramco  
June 2021



**55** U.S. Rock Mechanics  
Geomechanics  
Symposium  
Houston ☆ TEXAS 2021

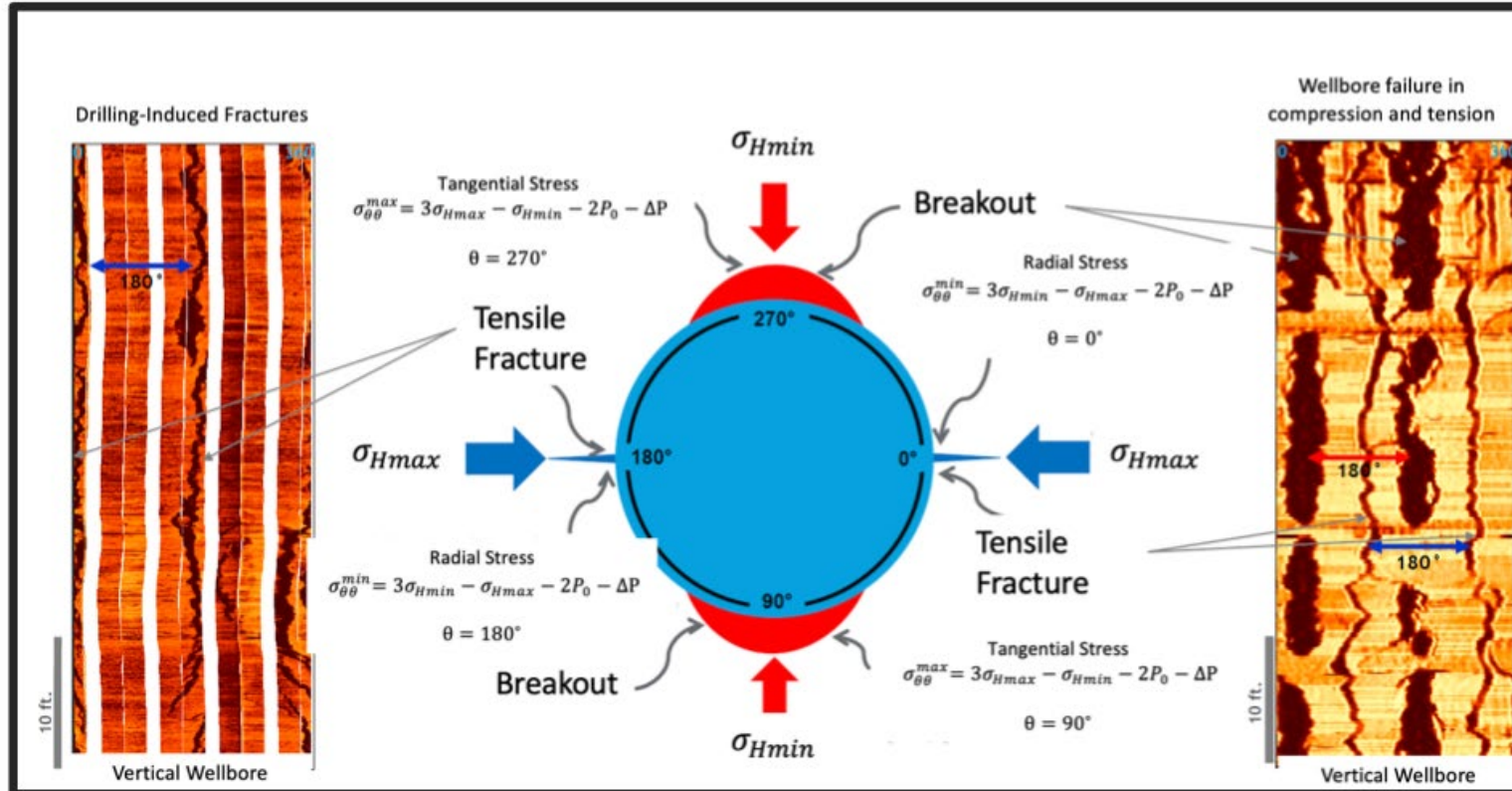
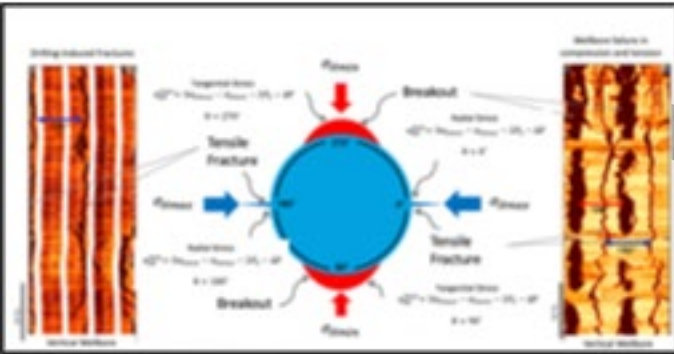


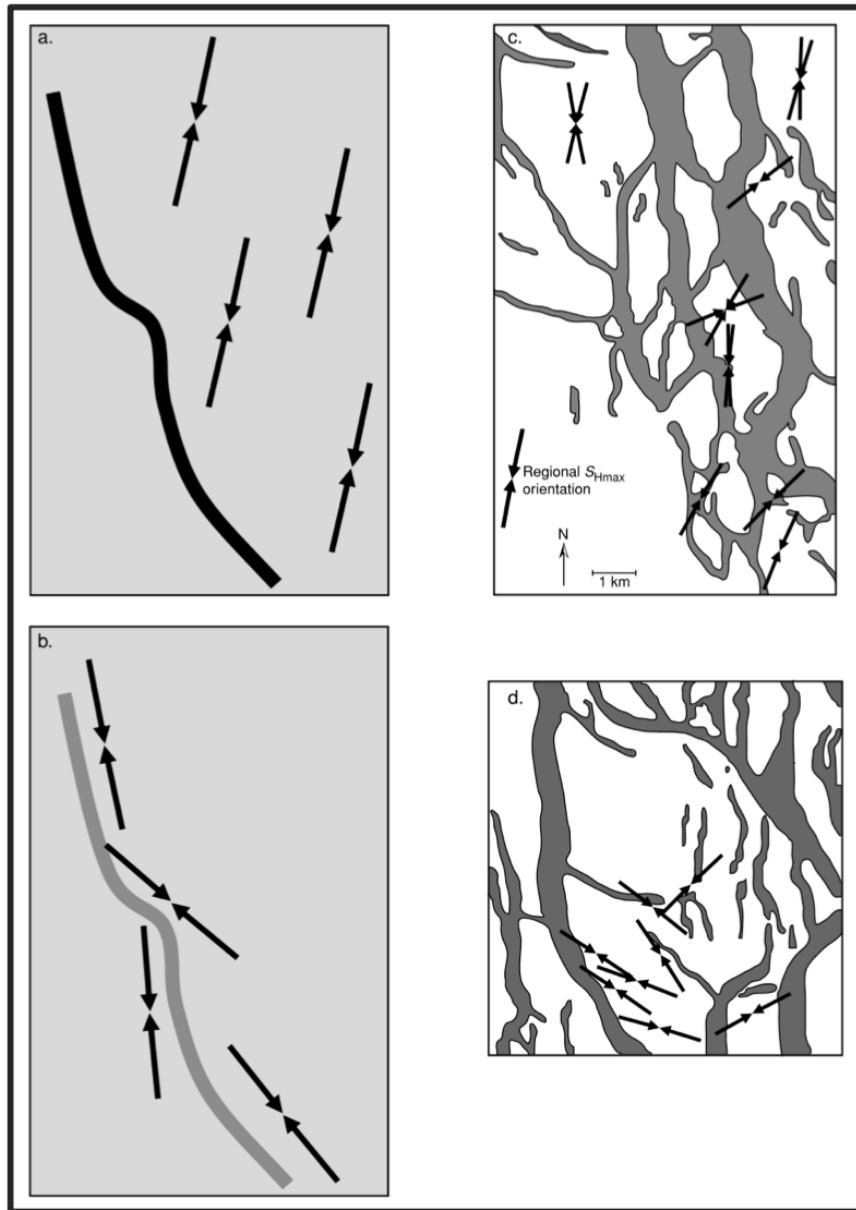
# Outline

1. Stress Rotation Background
2. Stress Rotation Assessment
  - Single wellbore analysis:
    - a) Image log interpretation
    - b) Finite Element modeling around producing wellbore
  - Field operations
    - a) Drilling events (mainly mud losses due to changing in well azimuth)
    - b) Orientation of hydraulic fractures
  - Field scale assessment
    - a) Finite Element modeling due to injection and depletion
3. Sensitivity Analysis
4. Impact of stress rotation in operations

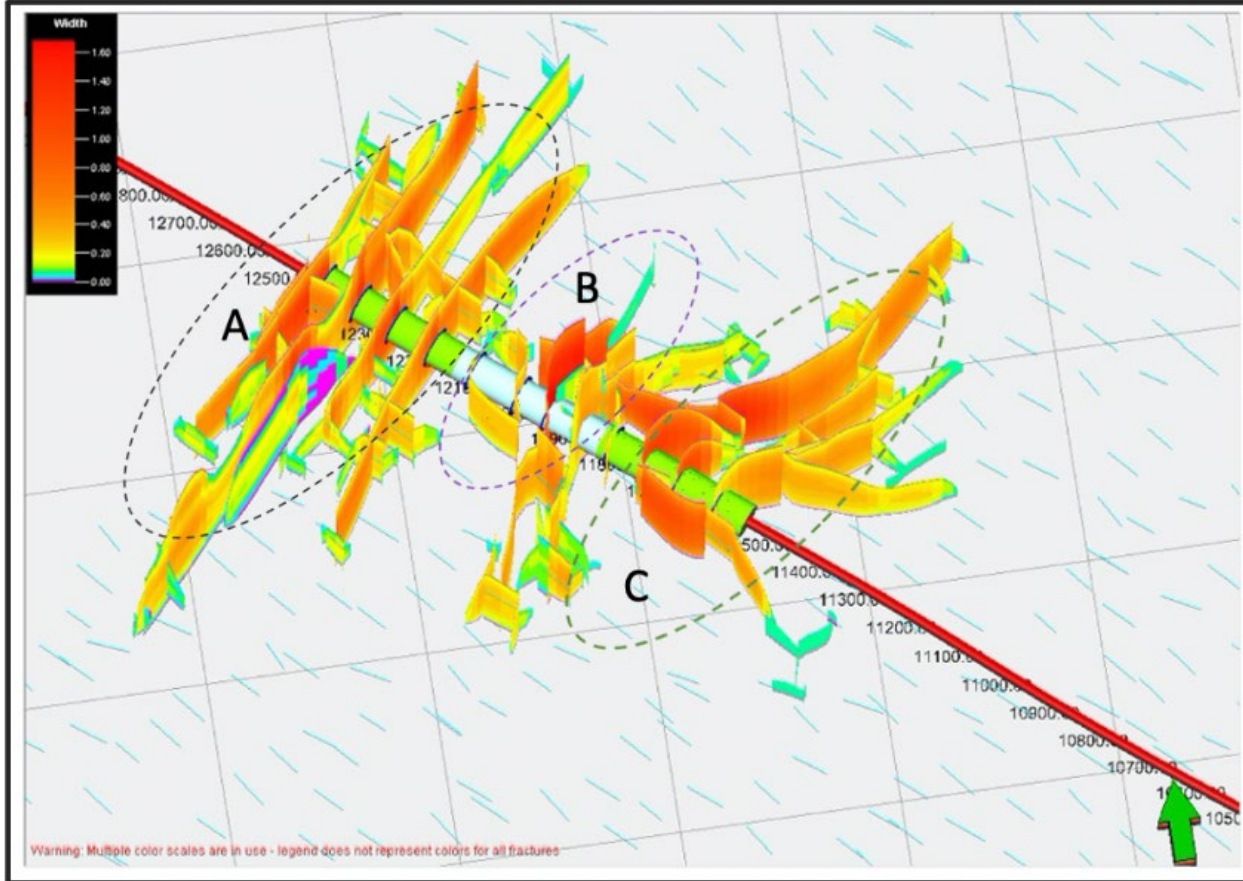
# Stress Rotation Background

# Stress direction from wellbore breakouts and drilling-induced fractures





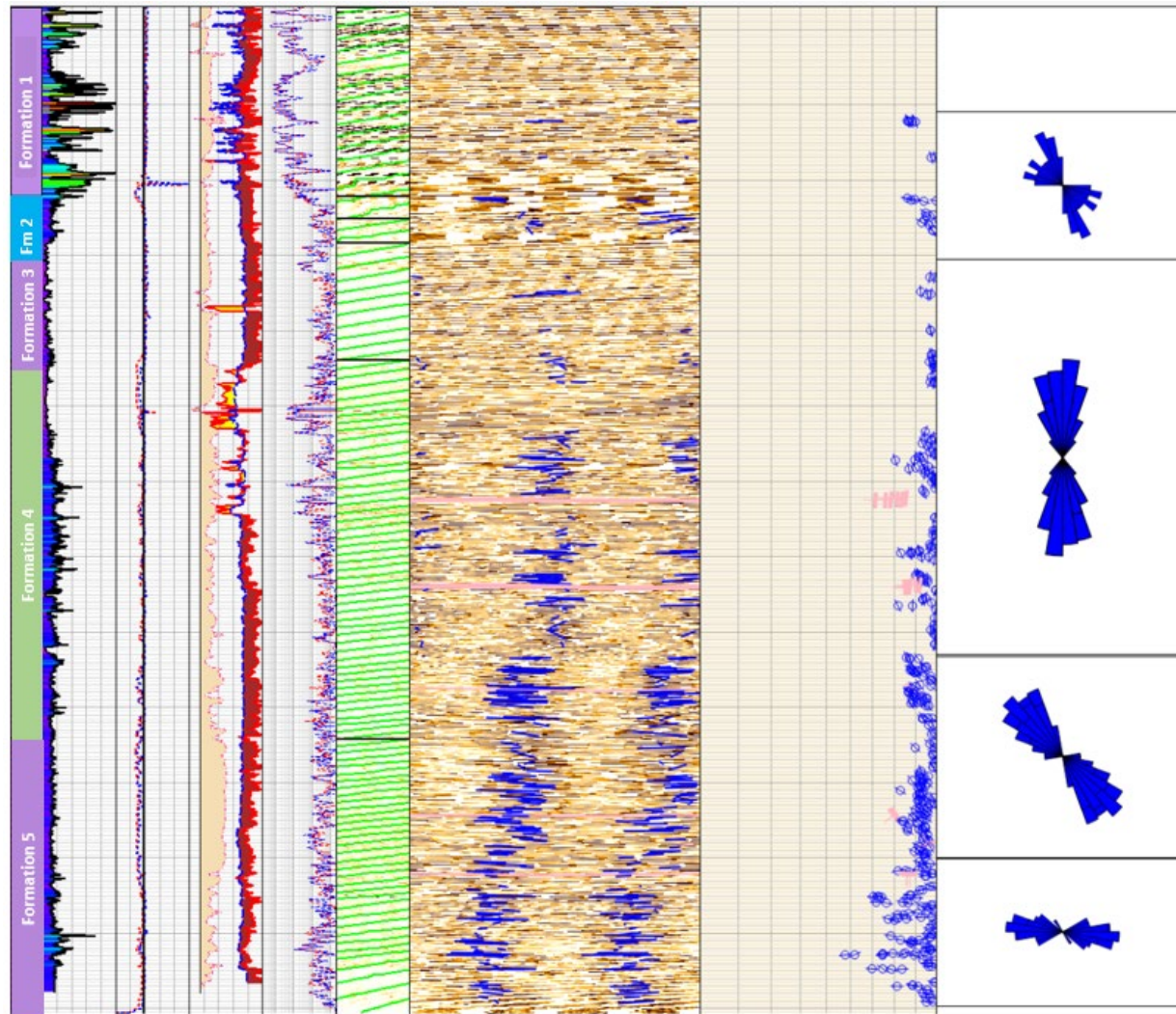
Horizontal stress rotation (a and b conceptual model before and after production respectively-Zoback 2007) (c and d from Arcabuz–Culebra field in Mexico - before and after production respectively Wolhart et al. 2000)



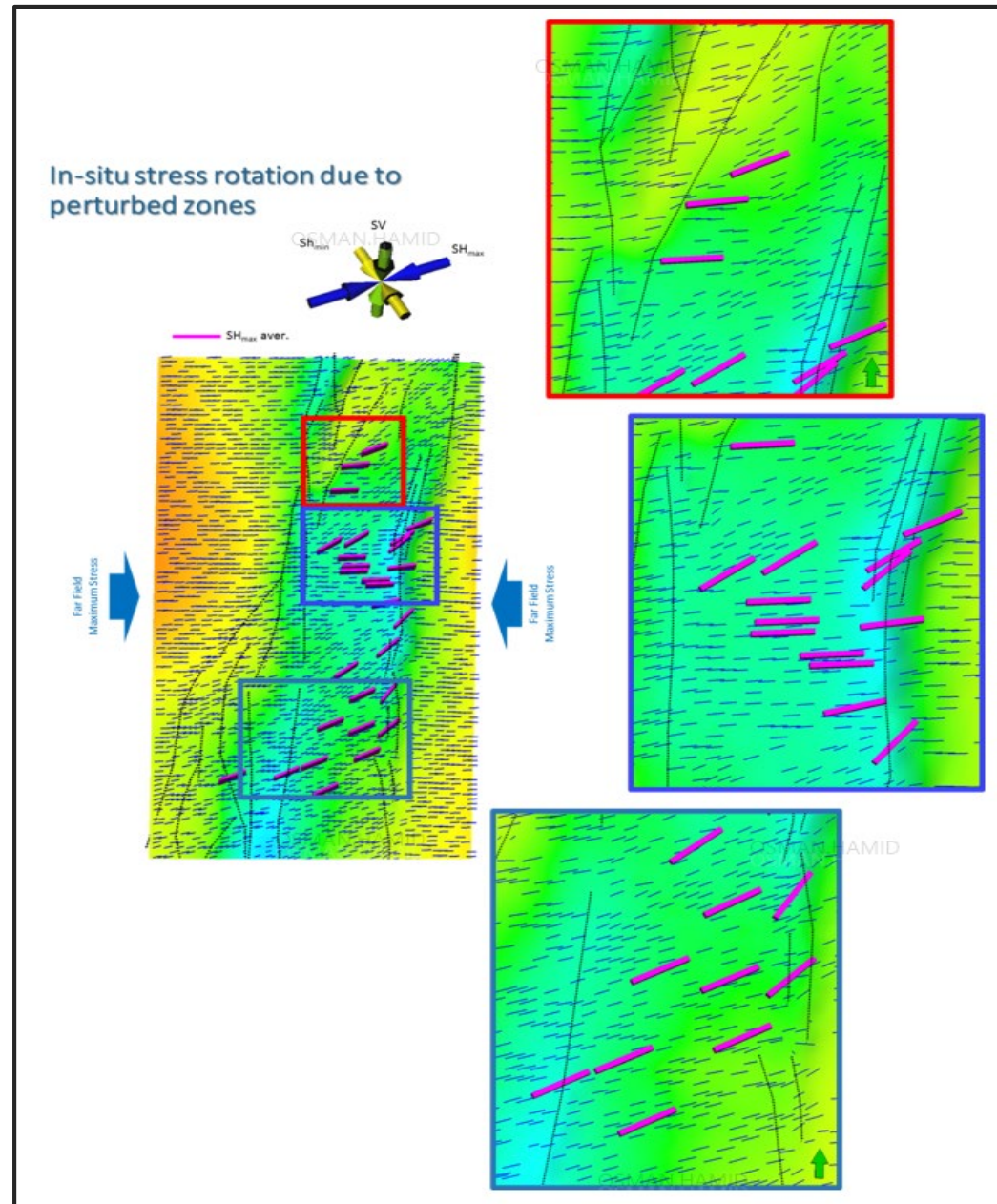
Hydraulic fracture network generated during first treatment stage, (b) Hydraulic fracture network developed during first and second treatment stage, and (c) Hydraulic fracture network generated during third treatment stage (Modified after Yew and Weng 2015)

# Stress Rotation Assessment

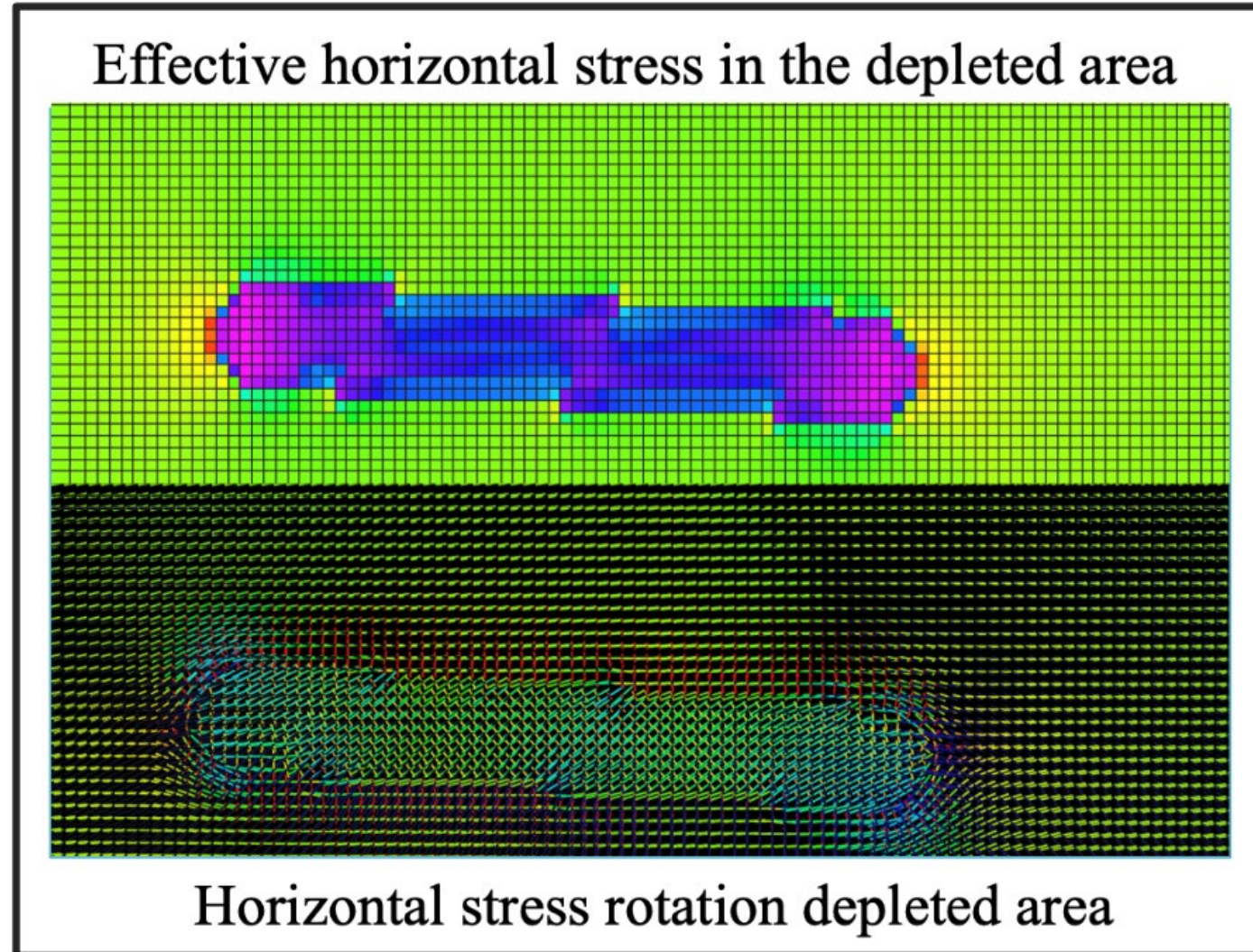
# Horizontal stress rotation interpreted from image log in a vertical well



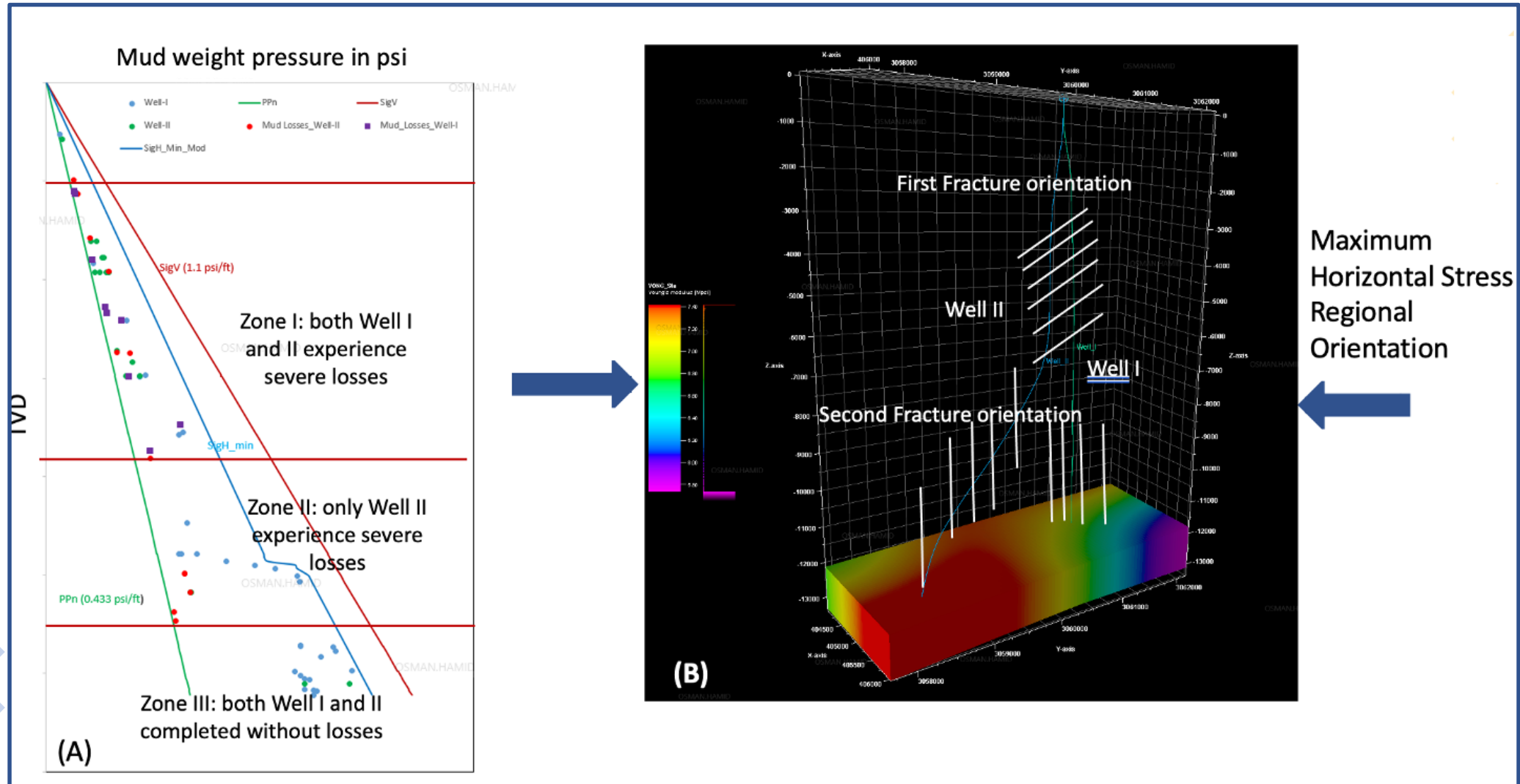
# Regional horizontal stress rotation



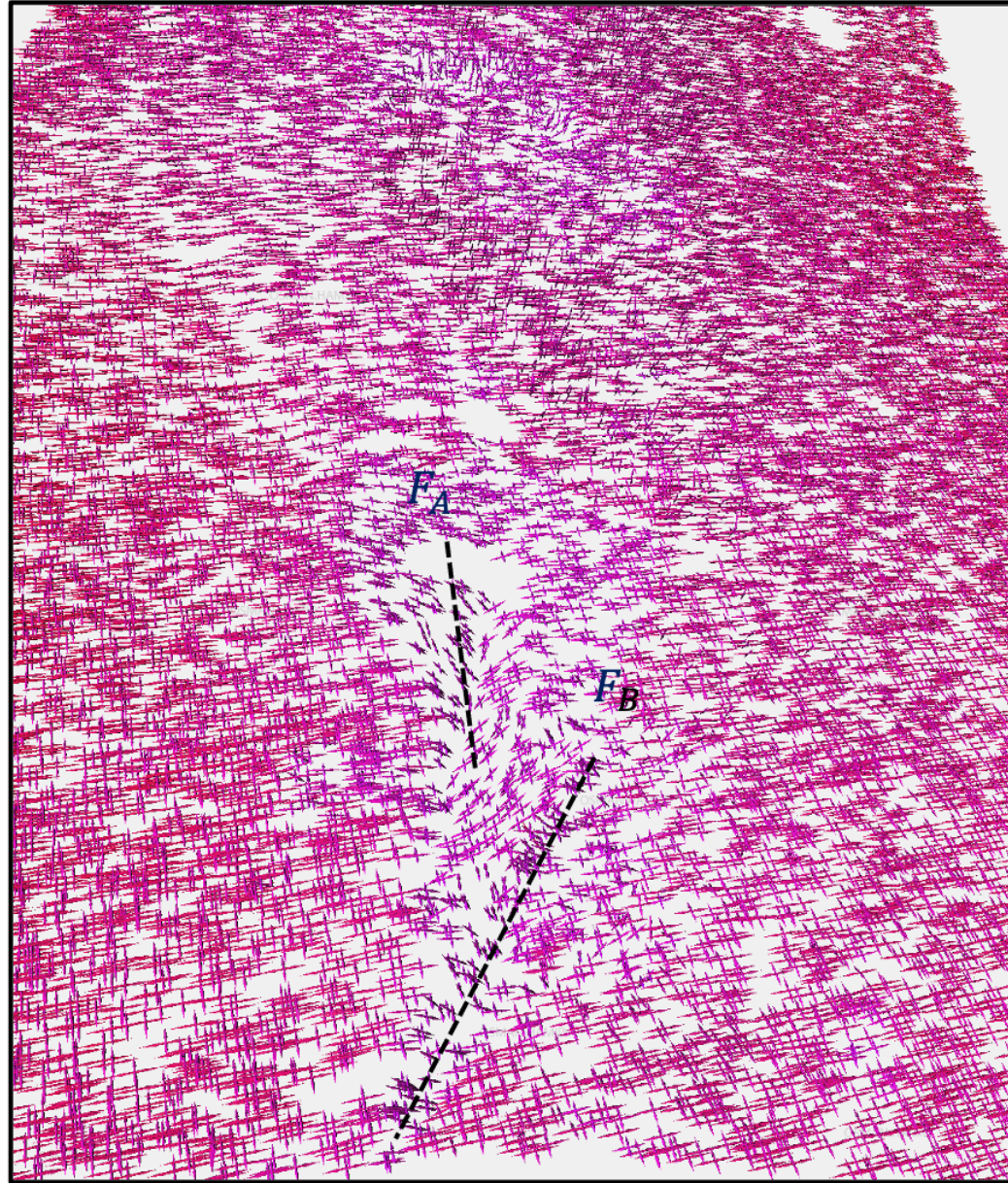
# Horizontal stress rotation interpreted Finite Element Simulation



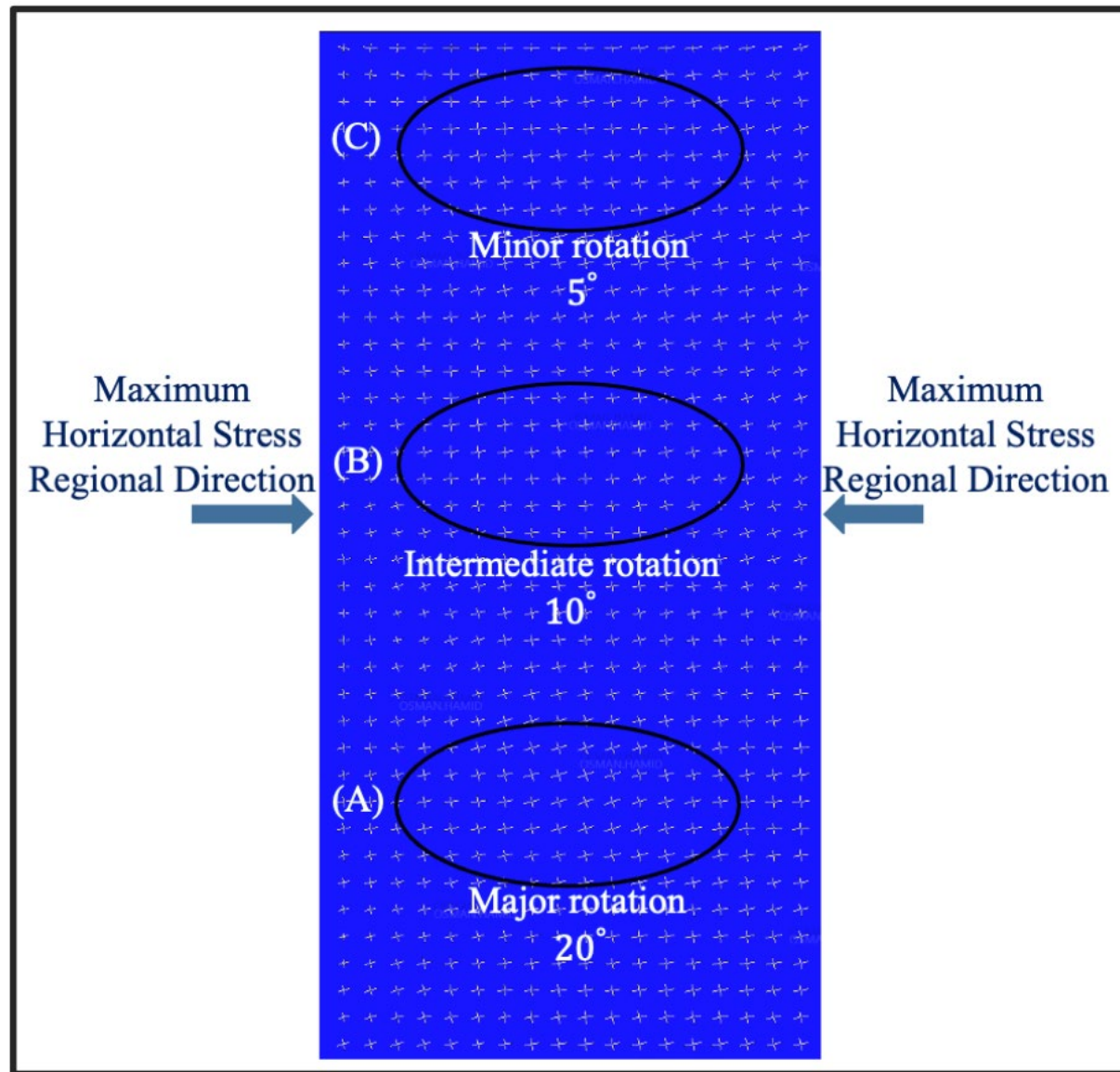
# Horizontal stress rotation concluded from severe lost circulation while drilling



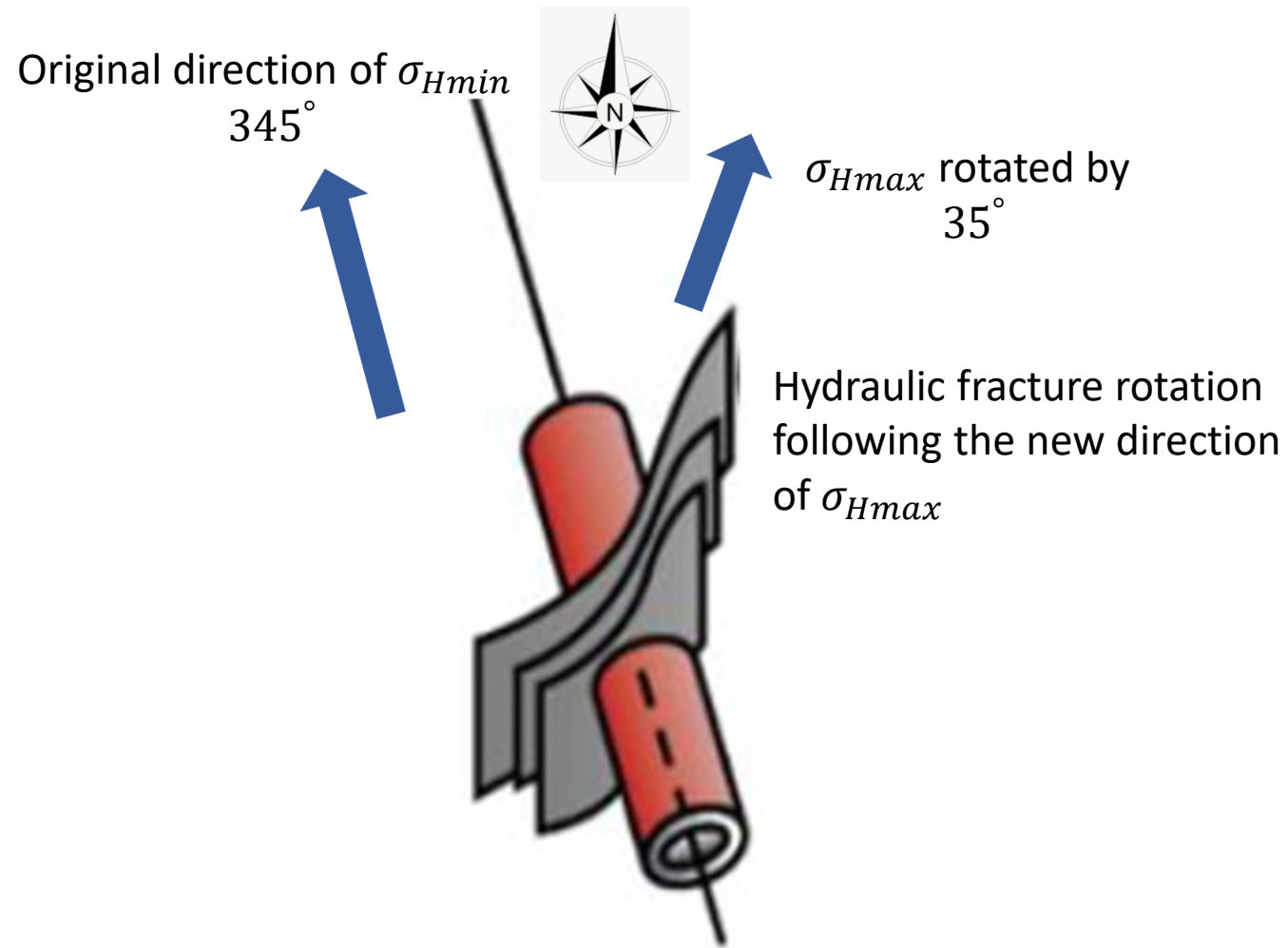
# Horizontal stress rotation modeling using Finite Element



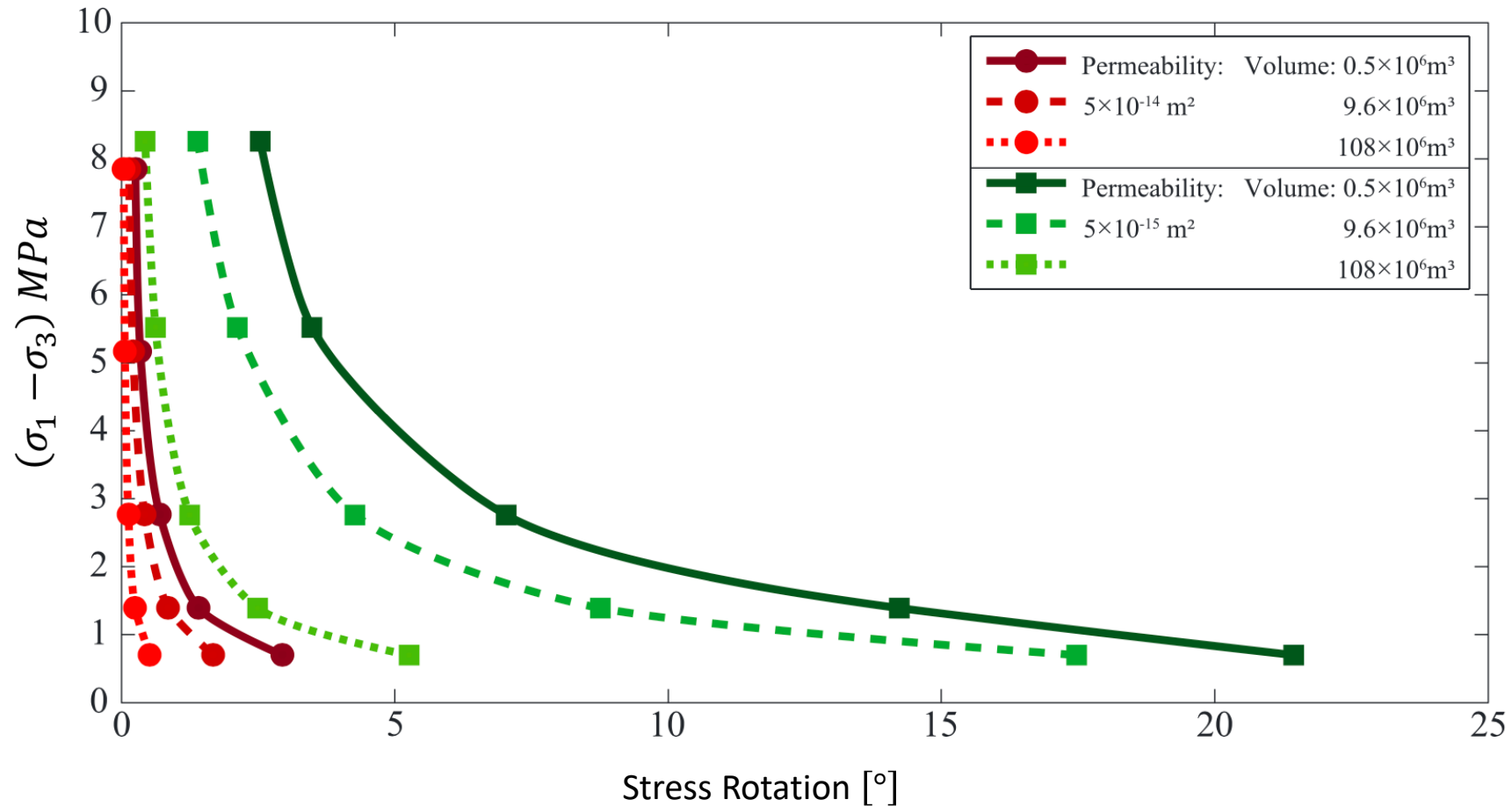
# Horizontal stress rotation for three depletion scenarios



# Impact of Stress Rotation on HF Propagation



# Relationship Between Permeability and Stress Rotation



Impact of stress re-orientation on field development

# Conclusion and Recommendations

- This research has investigated the horizontal stress rotations due to multiple tectonics events as indicated by circulation losses during drilling operations and depletion.
- Finite Element Models have been conducted to characterize the stress rotation.
- The orientation of the horizontal stresses ( $\sigma_h$ ) can be reoriented due to number of factors, including:
  1. Multiple tectonic forces acting into a reservoir
  2. Impact of hydrocarbon production or fluid/gas injection in high fractured/faulted areas
  3. Impact of multi-stage hydraulic fracture that generated stress perturbation in the vicinity of the fractures.