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Drilling geomechanical assessment using integrated reservoir workflow.

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

2021

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2020年9月16日-18日 中国•青岛 16–18 September 2021 in Qingdao, China

Drilling Geomechanical Assessment Using Integrated Reservoir Workflow

IFEDC20219783

Speaker:
Osman Hamid

Organization:
Robert Gordon University

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2. Mathematical Modeling (Analytical and Numerical

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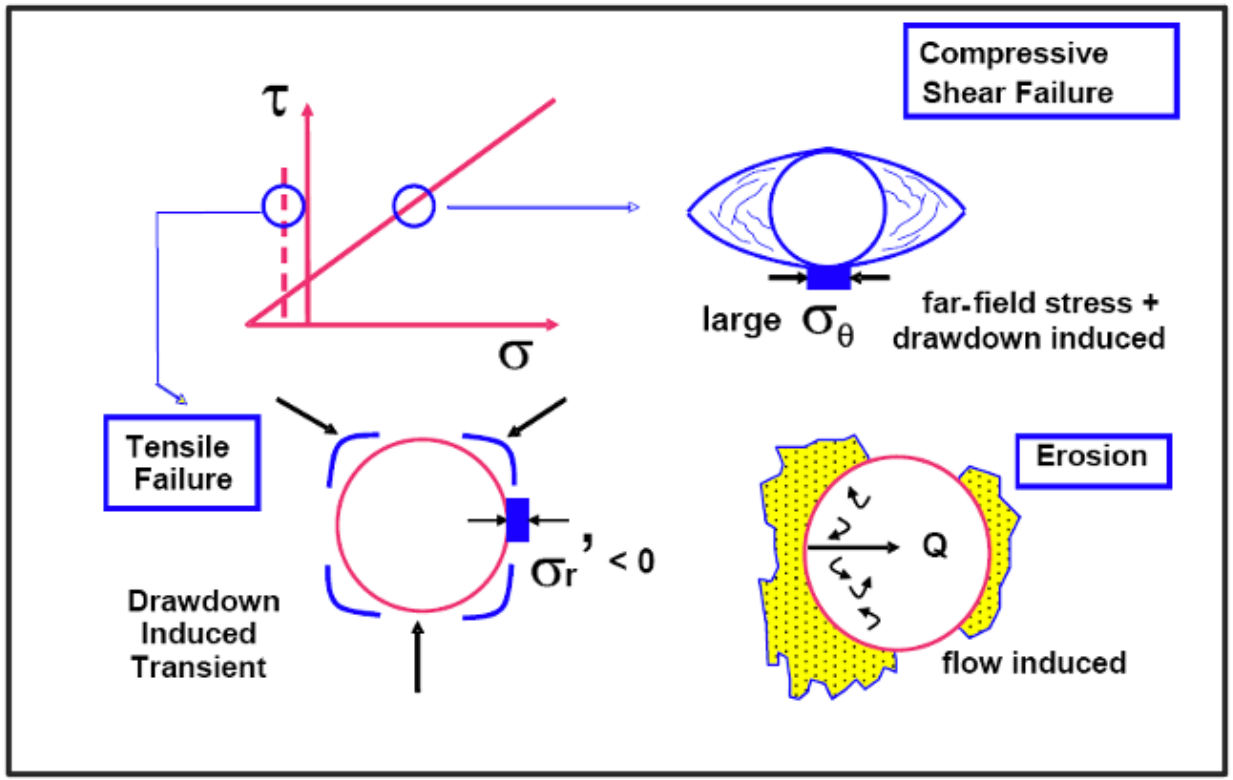
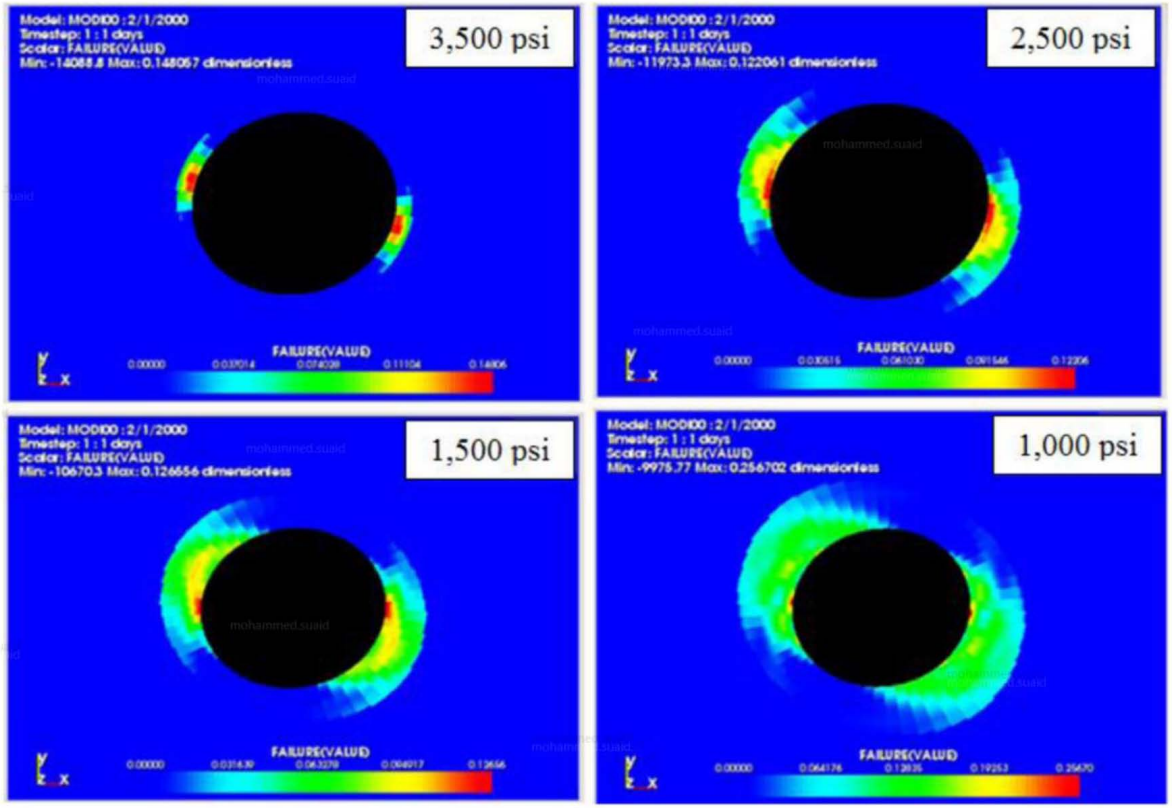
- Impact of Wellbore quality
- Conclusion

Rock Failure Mechanism



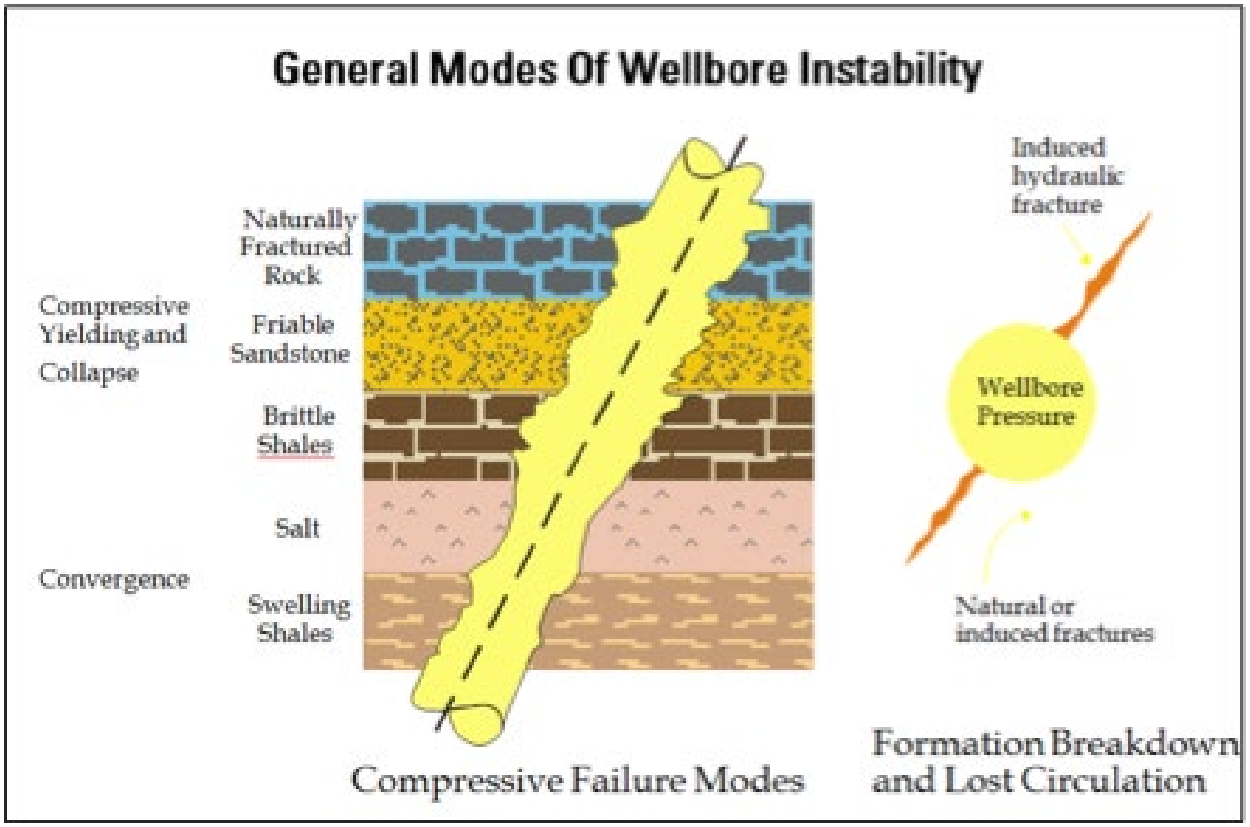
Veeken et al. 1991

A failure model that uses the Mohr-Coulomb criterion for different UCS values



Hamid et al., 2014

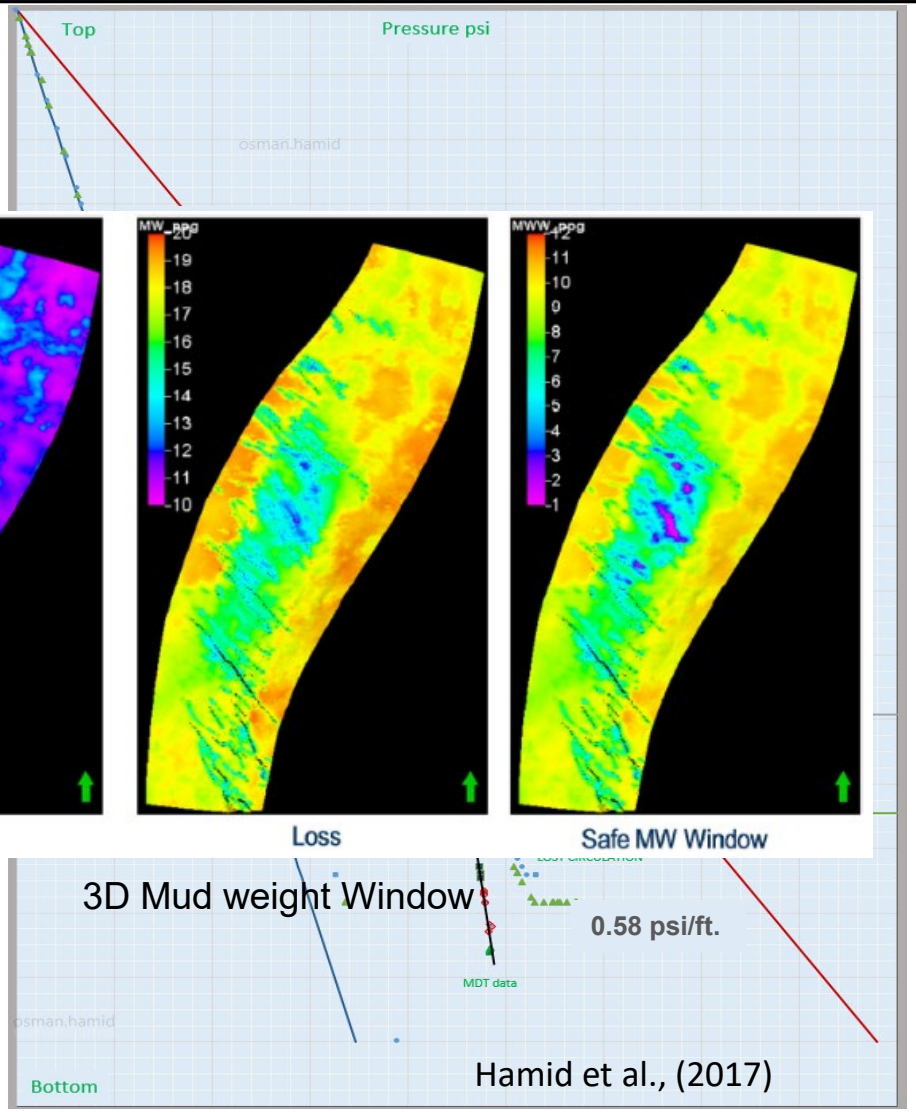
Types of Wellbore Stability



After Fjaer 2008

Global Mud-Weight Profile

- This plot suggested normal pore pressure regime for the first 5000 FT
- Then the pore pressure gradient increases to 0.48 psi/ft. and 0.52 psi/to till top of high-pressure Carbonate Formation
- High pore pressure up to 0.95 psi/ft. and then decreases at bottom of high-pressure Carbonate Formation



Empirical Modeling approaches:

The empirical method includes experience-based rules of thumbs and observation and laboratory model analogs, such as thick wall cylinder (TWC), wellbore collapse tests, and polyaxial cell.

Mathematical Modeling approaches:

1. Analytical models which can be closed-form solution including linear elastic, elastoplastic modeling, and kinematic considerations.
2. Numerical approaches include Finite Element (FEM), Finite Difference (FDM), boundary element (BEM), and distinct element (DEM).

Analytical Modeling approaches:

Linear Elastic

$$\sigma_r' = P_w - \alpha P_a$$

$$\sigma_\theta' = \sigma_{Max} + \sigma_{Min} - 2(\sigma_{Max} - \sigma_{Min})cos2\theta + A_p\Delta p - \alpha P_a$$

$$\sigma_z' = \sigma_V - 2\vartheta(\sigma_{Max} - \sigma_{Min})cos2\theta + A_p\Delta p - \alpha P_a$$

$$\tau_{r\theta} = \tau_{rz} = \tau_{\theta z} = 0$$

Analytical Modeling approaches:

Non-Linear Elastic

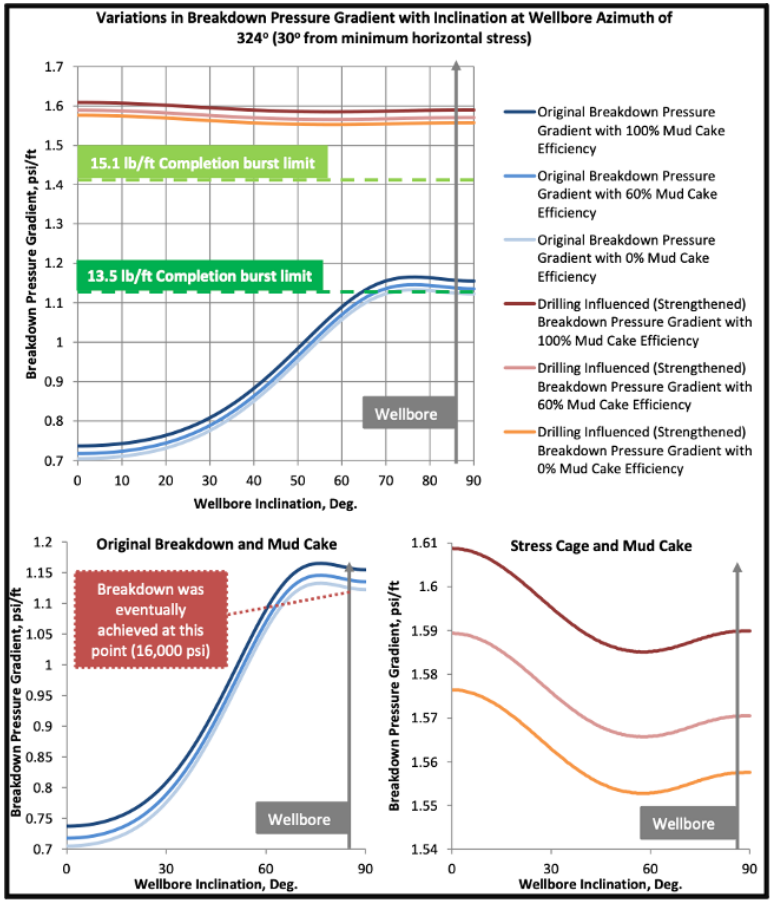
$$\frac{1}{N_p+1}\left[\{\sigma_{Ave}-\alpha p(R,t)\}(1-N_p)+S_p+A_p\left\{\frac{P_o}{2}(N_p-1)+p(R,t)\right\}\right]+\frac{S_r}{1-N_r}$$

$$-\left[p_w+\frac{S_r}{1-N_r}\right]\left(\frac{R}{r_w}\right)^{N_r-1}-\alpha_p(1-N_r)R^{N_r-1}\int_{r_w}^{R} r^{-N_r}\,p(r,t)dr+\sigma_{Ave}-\frac{A_pP_o}{2}=0$$

$$N_r=\frac{1+sin(\emptyset_r)}{1-\sin(\emptyset_r)}$$

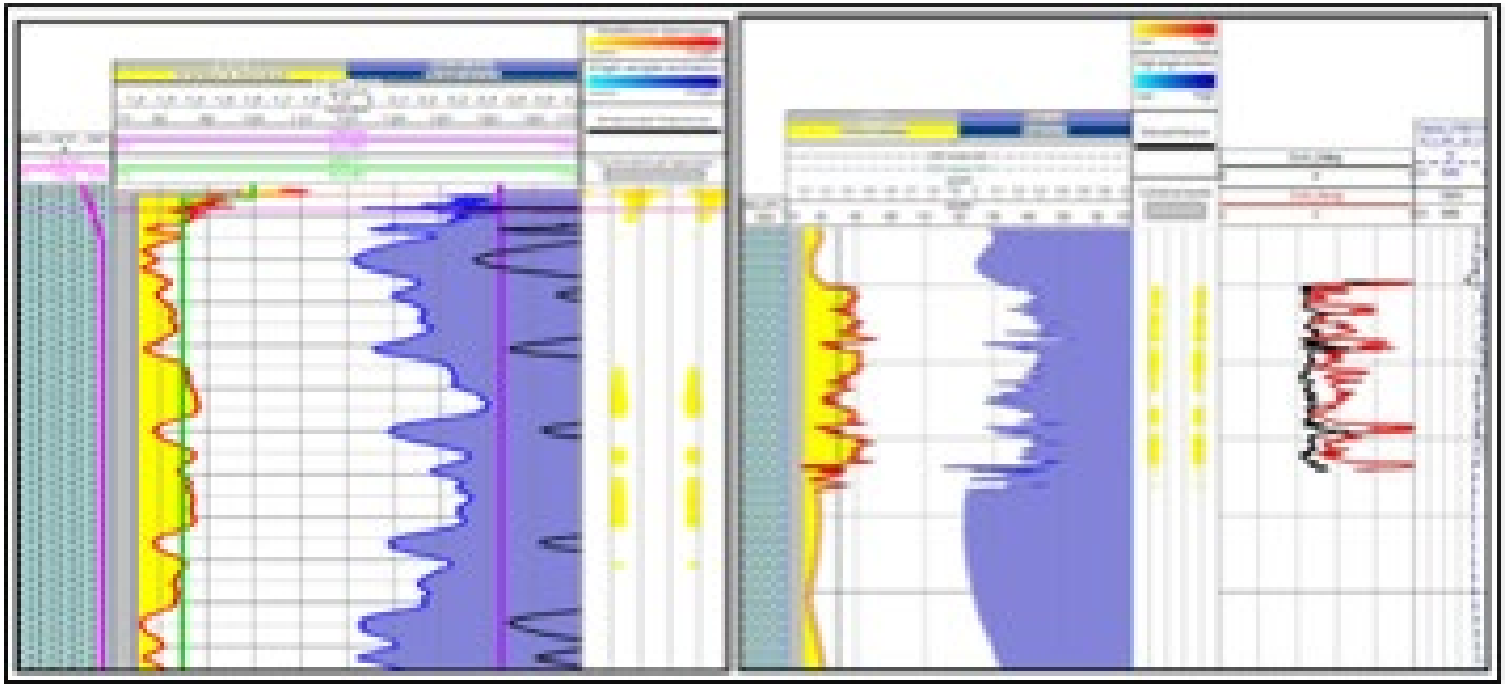
$$S_r=\frac{-2.c_r.cos(\emptyset_r)}{1-\sin(\emptyset_r)}$$

Variations in Breakdown Pressure Gradient with Wellbore Inclination and Filter Cake



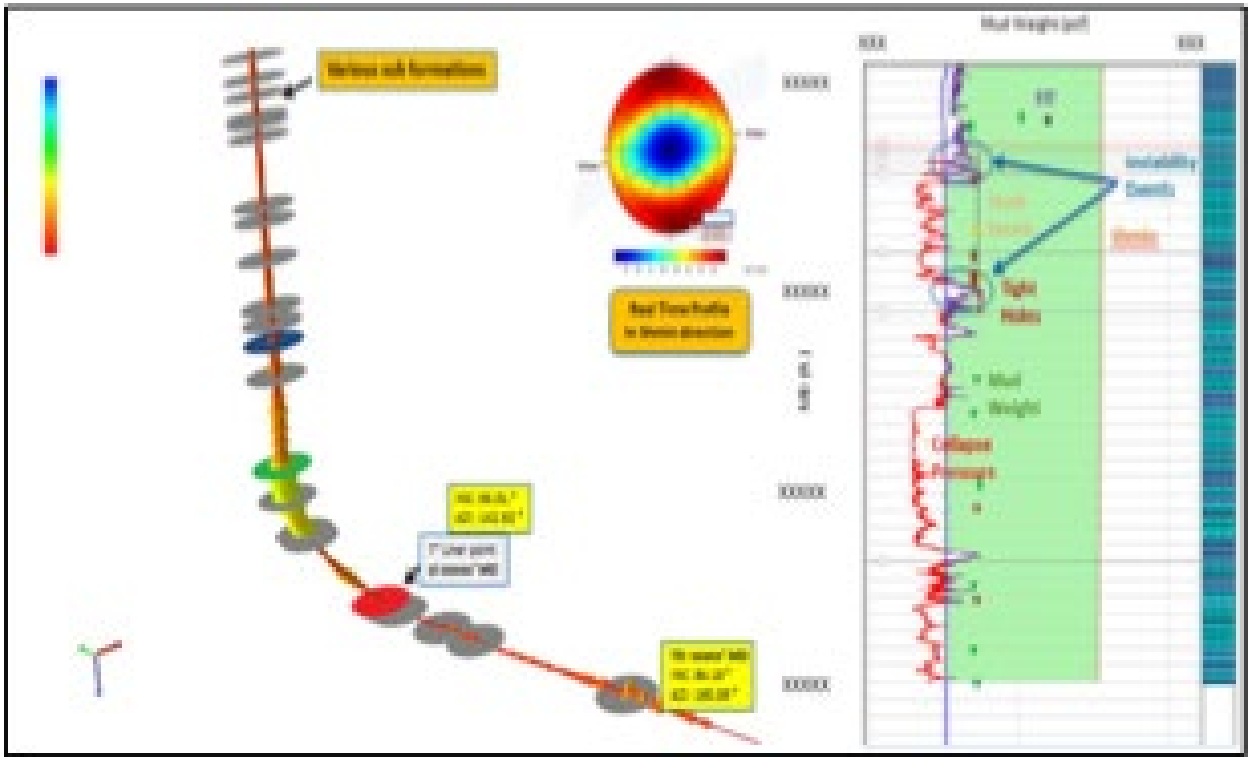
Albahrani et al. 2018

Pre-Drill on the left and RT Model Update on the right



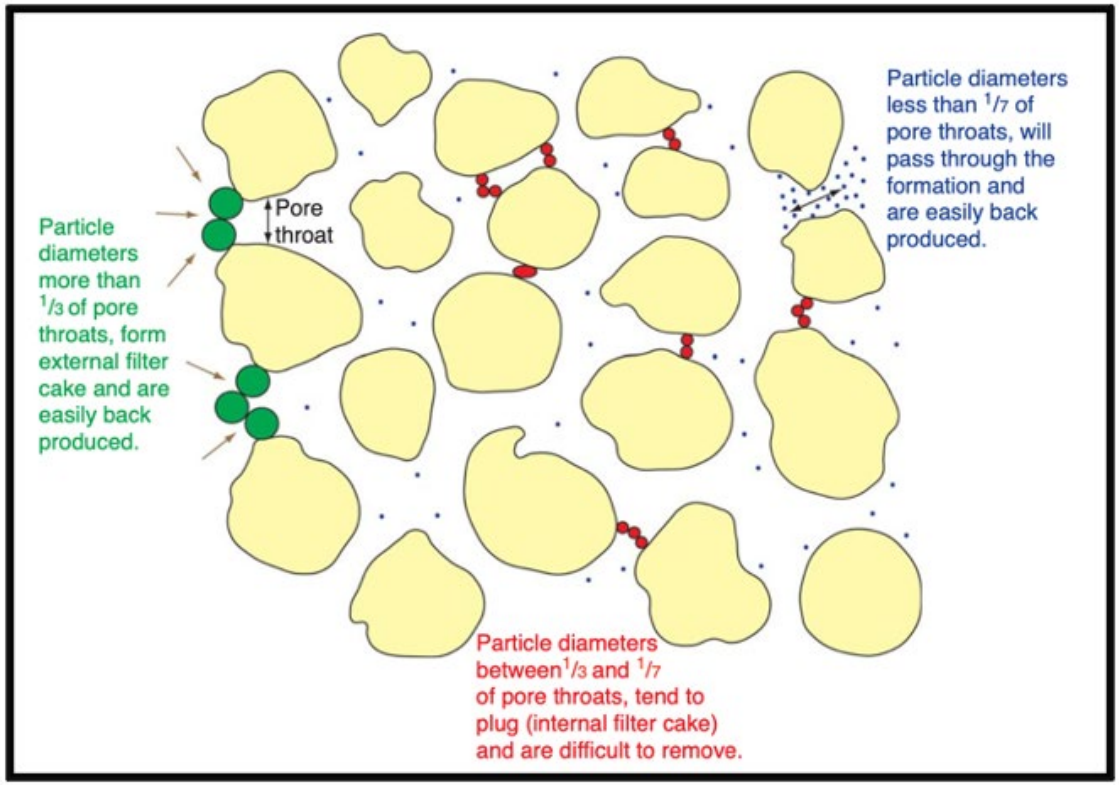
Hamid et al. 2016

Post-drill Geomechanical Model Updated with Drilling Results



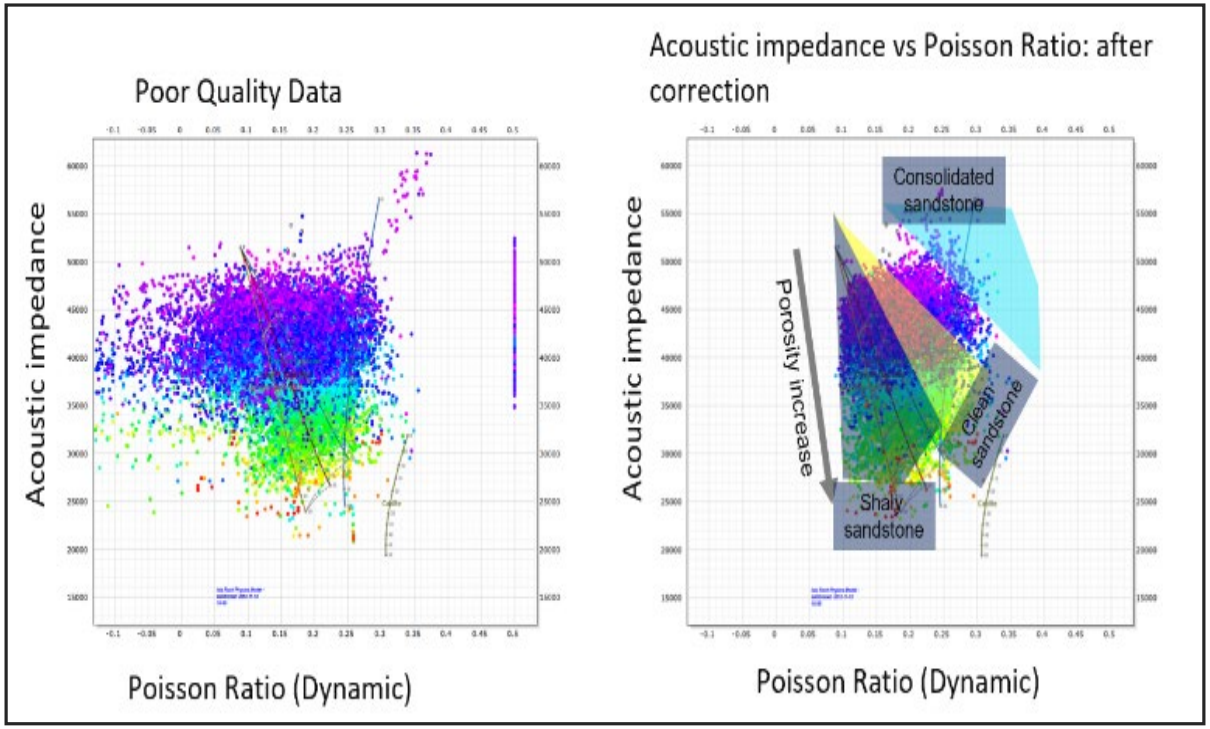
Hamid et al. 2018

The role of solids in bridging and plugging the formation

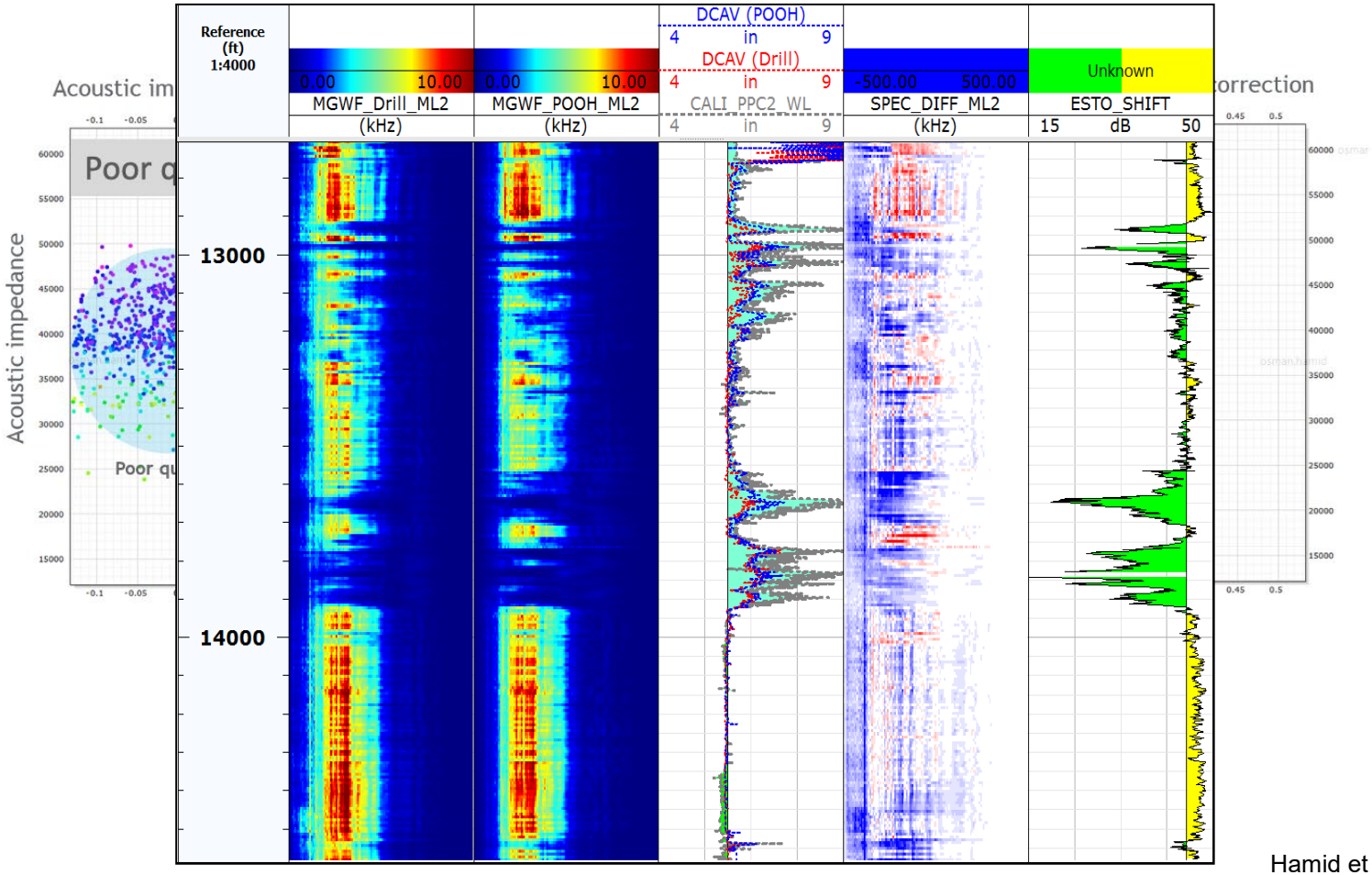


Jonathan 2009

Impact of Wellbore Quality on Petrophysical logs



Impact of Wellbore Quality



Hamid et al. 2017

Conclusion

Applying this workflow will lead to:

1. Better wellbore quality to ensure better quality log data.
2. High success rate of completion and stimulation operations, which leads to maximizing hydrocarbon production and
3. Save time and money.

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I would like to thanks my Co-authors Dr. Reza Sanaee and Dr. Gbenga Oluyemi

谢谢大家！