Caprock integrity analysis

Determines the optimum injection pressure to maximize bottomhole injectivity and avoid overpressure risk

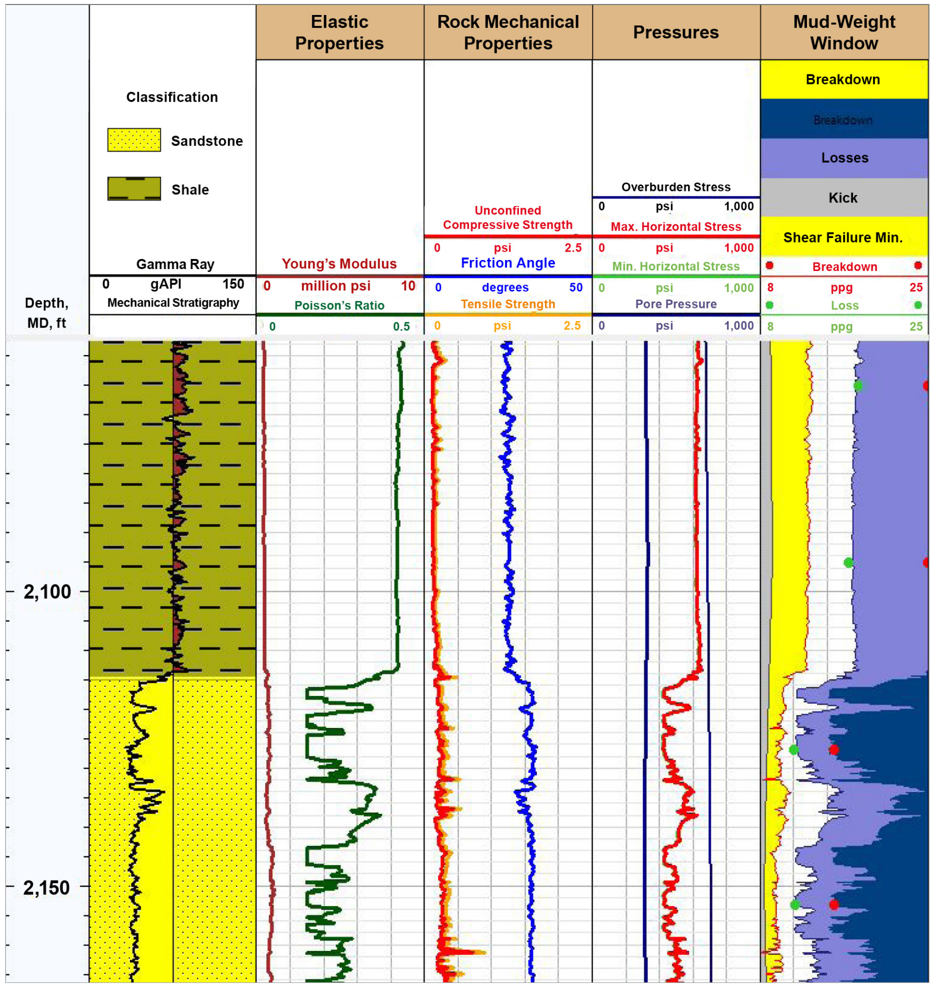
Applications

- Carbon capture and storage (CCS)
- Water injection
- Enhanced oil recovery (EOR) when related to fluid injection

For CCS operations, it is critical to ensure the strength of the caprock because the potential risks associated with leak of stored CO2 is high. The main objective is to determine the optimum injection pressure to maximize the bottomhole injectivity without risking reservoir overpressure. This assessment is also needed to optimize EOR techniques and enhance underground gas storage. Caprock integrity analysis helps determine safer injection pressure limit for caprock integrity, safer depletion limits, pressure support, and cutting injection.

How it improves performance

- Optimizes injection pressure for gas storage, carbon capture, or EOR without jeopardizing caprock integrity
- Complies with government regulatory site assessment applications
- Assesses fault activation risk during injection
- Calibrates geomechanical earth model integrating all available data such as core, images, stress testing results, and anisotropic stress modeling
- Analyzes the sensitivity of injection pressures for potential faults in the caprock by integrating data from borehole seismic, sonic imaging, or surface seismic interpretation



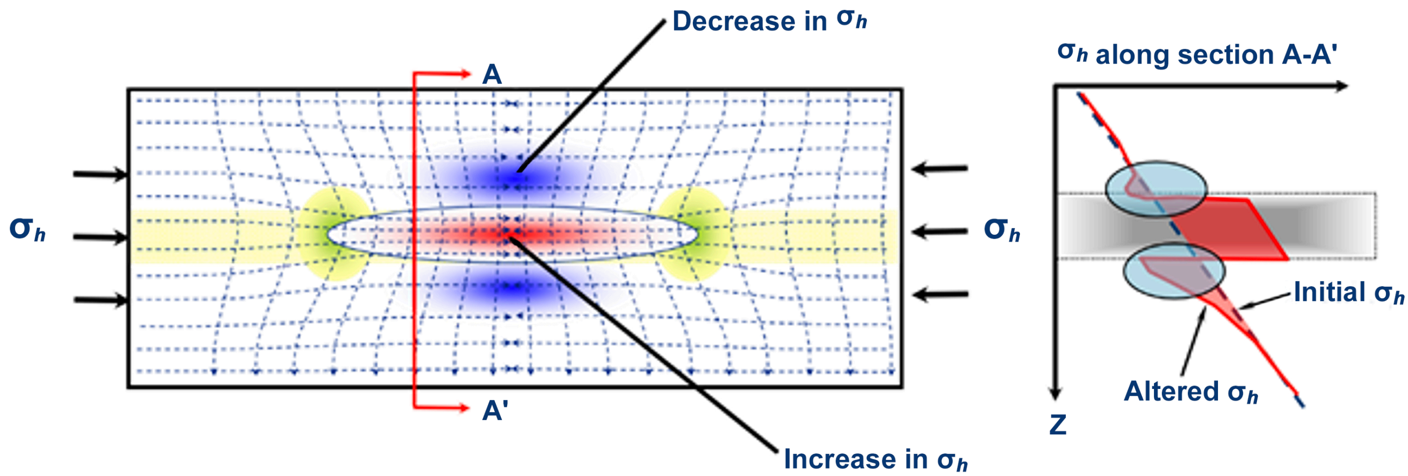
Wellbore-specific caprock integrity analysis.

How it works

Caprock integrity analysis incorporates the processing results of borehole images, acoustics data, and pressure tests. A 1D mechanical earth model (MEM) is constructed to determine different rock mechanical strength properties, (anisotropic) elastic properties, accurate pore pressure, and in situ stresses.

Minimum horizontal stress is determined by various field measurements related to tensile fracture openings, fracture closures, and controlled flowback. These tests also provide the formation breakdown pressure, which is useful for caprock integrity analysis. The test results are used to calibrate the computed horizontal stresses and rock strengths in the 1D MEM.

A detailed caprock integrity analysis helps estimate safer injection pressures for the injection zones and pressures in the surrounding upper and lower formations. This enables design of the fracture modeling with certainty in the injection wells and boosts confidence in the EOR techniques and injection operations.



Stress distributions for caprock integrity analysis observed along the section A-A; for the minimum horizontal stress σ_h.

Inputs

→ Conventional openhole logs (gamma ray, density, and porosity)

→ Acoustic anisotropy, radial profile results, and transverse isotropic properties

→ Stress testing with dual packers

→ Formation pressure tests and well test results

→ Natural fracture data from 3D far-field sonic imaging logs

→ Structural maps

→ Rock strength and elastic properties for unconfined compressive strength, Young's modulus, and Poisson's ratio from laboratory core test results

The takeaways

→ Calibrated 1D mechanical earth model

→ Integrated data from core, stress testing results, wellbore imaging results, and anisotropic stress modeling

→ Maximum injection pressure for CO_2 injection or EOR operations

Learn more

Cig, K., et al.: "Use of Wireline Formation Tester Stress Measurements and Sonic Logs for Improved Geomechanical Model Construction of a Giant Depleted Gas Reservoir in Abu Dhabi Land," paper at IPTC (January 2014) IPTC-17213-MS https://doi.org/10.2523/IPTC-17213-MS

Povstyanova, M., et al.: "Stress Testing with Improved Wireline Formation Tester in Low Permeability Unconventional Formation," paper at ADIPEC (November 2018) SPE-193272-MS https://doi.org/10.2118/ 193272-MS

slb.com/SonicScanner