Rock Mechanics Essentials for Drilling

Description
Geomechanics is an essential part of any well design and well construction programme. It is well known that more than 70% of non-productive time (NPT) and increases in drilling costs is related to wellbore instabilities. Estimated annual wellbore instability expenditure is in billions of dollars worldwide. Proper understanding and application of geomechanics has been proven to save billions of dollars in the industry. Drilling engineers equipped with basic geomechanics knowledge can minimise many of these risks, reduce NPT, and optimise their drilling programmes.
This one-day introductory geomechanics course for the drilling community will cover the basics of rock mechanics, physical meaning of mechanical properties, the process of deriving them from logs and cores, rock strength, and rock failure. Special emphasis will be placed on understanding earth stresses versus wellbore stresses, pore pressure, fracture gradient, predicting safe mud weight window, and wellbore stability analysis. Practical guidelines on monitoring real-time indicators of wellbore instabilities and ways to mitigate them will be provided.

Course Outline
1. Basic Mechanics
   - Concept of stress/strain
   - Mechanical properties—Young's modulus, Poisson's ratio, bulk modulus, shear modulus, bulk compressibility
   - Rock strength—UCS, tensile strength, and shear strength
   - Computation of mechanical properties and strength parameters from logs
   - Dynamic to static conversion of mechanical properties

2. Understanding Earth Stresses
   - In-situ stresses and plate tectonics
   - Computing stress profile from logs
   - Stress measurement and calibration—mini-frac/LOT/MDT tests
   - Basic definitions of fracture gradient, closure pressure, and other terminologies used in lot/xlot
   - How fractures are created—preferential direction, fracture growth (frac height and width)

3. Pore Pressure and Fracture Gradient Estimation
   - Normal, under, and overpressure reservoirs
   - Measuring, predicting, and modelling of pore pressure
   - Use of 3D seismic in pore pressure estimation and modelling
   - Pore pressure and the principle of effective stress

4. Rock Failure
   - Tensile versus shear failure
   - Mohr-Coulomb criterion for rock failure
   - Identifying rock failure from logs

5. Wellbore Stability
• Factors causing wellbore instability
• Modelling and predicting
• Use of cavings and drill cuttings
• Planning proactively to avoid/reduce wellbore instabilities
• Rock mechanics in bit design

6. Mechanical Earth Modelling (MEM)
• Data requirements for a typical geomechanical analysis
• Process of building mechanical earth model
• Log data—Dipole Sonic Imager (DSI) and Sonic Scanner
• Integrating log data, core data, and field stress measurements in MEM
• Calibration of geomechanical model

Instructor

Safdar Khan currently holds the position as senior geomechanics engineer, Schlumberger, Canada. Khan holds a PhD in geomechanics from the University of Toronto. He has over 15 years of extensive research and consulting experience in the oil and gas industry. He is currently engaged in a number of unconventional reservoir geomechanics projects dealing with the impact of geomechanics on heavy oil recovery operations, thermal, non-thermal and CHOPS, caprock integrity analysis, coupled thermal reservoir modelling, anisotropic stress profiling, wellbore stability analysis, and stimulation design for shale gas and tight sand. He has authored/co-authored a number of technical papers, and given numerous technical presentations and short courses on geomechanics internationally.