Practical Geomechanics: A Short Course

Instructor: Tom Bratton, PhD

Course description

In today's economy, engineers design and carry out both drilling and completion operations with insight gained from geomechanical simulations. These simulations lead to significant cost reductions and improved hydrocarbon recovery. Thus, geoscientists that support engineering operations need to understand the basics of geomechanical modeling, the workflow, and supporting data to influence the engineering and financial decisions that contribute to their organization's success. The goal of this workshop is to give the geoscientist an overview of this highly leveraged process as well as some practical tools to help understand and evaluate geomechanical models used in downstream geomechanical and engineering simulations. Short exercises in the form of Excel spreadsheets will be used to illustrate different geomechanical models.

Course content – Session 1

1) Introduction – This unit introduces and motivates the use of geomechanics in engineering design by illustrating the overall workflow and showing examples where geomechanical understanding led to significant cost reductions and improved hydrocarbon recovery.
2) Rock mechanics – This unit introduces and defines the nomenclature used in geomechanics: stress, strain, elasticity, elastic moduli, yield, failure, Mohr's circles and the Zoback's stress polygon.
3) Calibration data – Laboratory measurements of elastic moduli and rock strength parameters are important to compare with the equivalent log derived values. In addition, in-situ stress testing is needed for the calibration of modeled stresses. This unit introduces the use of calibration data to support a geomechanical model.
    a. Laboratory testing – This unit introduces the different laboratory tests used to measure rock properties and illustrates the rock properties are derived.
    b. In-situ stress testing – This unit explains different in-situ stress tests and illustrates how they are used to measure pore pressure and stress.

Course content – Session 2

4) Dipole acoustic and imaging logs – This unit explains dipole sonic log processing and how to compute both isotropic and anisotropic dynamic elastic moduli. This unit also includes wellbore image analysis, how the geomechanical features are identified, and how to differentiate natural fractures from drilling induced fractures.
5) Static moduli and rock strength parameters – This unit introduces different correlations to estimate static moduli and rock strength parameters and how to integrate dynamic elastic properties with laboratory measurements on core.

6) Overburden stress and pore pressure – The stress loading on formation layers are critical inputs to engineering operations. This unit discusses the methods available to quantify overburden and pore pressure and how to select the best method for any given geological environment.
7) Horizontal stresses – This unit explains how horizontal stresses in the earth are modeled and calibrated to both in-situ measurements and observations from drilling and completion operations.

Course content – Session 3

8) Wellbore stability – This unit introduces the theory of wellbore instability; formation collapse leading to breakouts and hydraulic fracturing leading to lost circulation. In addition, it covers the diagnosis of different instability mechanisms and common mitigation practices for overcoming these instability problems.
9) Case studies – Several case studies will be presented that illustrates the building of the mechanical earth model and the use of the model in solving wellbore instability problems.

The course materials include the Excel spreadsheets used in building the mechanical earth model and wellbore stability exercises, presentation slides, sources of information, websites, and references to important technical publications.

Who should attend?

I have developed this course for geoscientists and engineers who want a better understanding of geomechanics and some guidance in how to use the geomechanical results to influence engineering decisions.

Prerequisites (Knowledge/Experience/Education required)

Students should have a basic understanding of well logs and drilling and completion operations.

Instructor biography

Tom Bratton is currently a consultant to the oil & gas industry. He started his career with Schlumberger, working in the field as a wireline engineer. He specialized in petrophysics, geophysics, and geomechanics with a broad base in drilling and completion engineering. While at Schlumberger, Tom helped develop the concept, introduction, and commercialization of the Mechanical Earth Model. He retired as a Scientific Advisor to Schlumberger's senior management after leading Schlumberger's technical communities on a global scale. After his Schlumberger career, he was a Visiting Professor and Research Associate in the Petroleum Engineering Department at Colorado School of Mines. While at CSM, he enrolled as a graduate student and earned his PhD in Geophysics. Tom is a full member of the Society of Petroleum Engineers (SPE), Society of Petrophysicists and Well Log Analysts (SPWLA), Society of Exploration Geophysicists (SEG), European Association of Geoscientists and Engineers (EAGE), and the American Rock Mechanics Association (ARMA).