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 in order 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 build the geomechanical models needed for downstream geomechanical and engineering simulations.

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: pressure and stresses, strain, elasticity, elastic moduli, Mohr's circles, yield, and failure.
3) Calibration data – Laboratory measurements of elastic moduli and rock strength parameters are important in order 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 explains how the rock properties are derived.
    b. In-situ stress testing – This unit explains the different in-situ tests and how they are used to measure pore pressure and stress.
4) Dipole acoustic and imaging logs – This unit explains how logs measure in-situ geomechanical properties, estimate mechanical behavior, and how to integrate laboratory measurements on core with these data. This unit also includes wellbore image analysis, how the geomechanical features are identified, and how to differentiate natural fractures from drilling induced fractures.

Course content – Session 2

5) 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.

6) 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.
7) Wellbore stability – This unit introduces the geomechanical theory of wellbore stability. In addition, it covers the diagnosis of different instability mechanisms and common mitigation practices for overcoming these instability problems.
8) Hydraulic fracturing – This unit introduces the geomechanical theory of hydraulic fracturing and is presented from a drilling-lost-circulation point of view.

I will present this course using examples from the many papers and case studies I have been involved with over the course of my career. The course materials include the 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).