Technical Workshop on Geomechanics

Date: Friday April 18th 2025

Location: SGF, 77 rue Claude Bernard, 75005 Paris

Start time	End time	Presenter	Title	Company
09:45	10:00		Welcome and introduction	SPWLA France
10:00	10:30	Kun Su	Characterisation of the creeping capacity of a rock from logs data: some in situ cases	TotalEnergies
10:30	11:00	Thomas Berard	A New Formation Test for the In-Situ Measurement of Rock Static Elastic Properties	SLB
11:00	11:15		BREAK	
11:15	11:45	Kun Su	Identifying simple geomechanical criteria to assess the risk of losses during drilling operations nearby faults	TotalEnergies
11:45	13:30		LUNCH	
13:30	14:00	Elisabeth Bemer	Integration of intrinsic geological heterogeneity in coupled reservoir-geomechanical models for large-scale CO2 storage	IFPEN
14:00	14:30		BREAK	
14:30	15:00	Andreia Mandiuc	Geomechanical modeling overview (1D/3D MEM construction)	SLB
15:00	15:15		Conclusion remarks	SPWLA France

Identifying simple geomechanical criteria to assess the risk of losses during drilling operations nearby faults

Céline FLIEDNER, Jan BORGOMANO, Kun SU
OneTech, TotalEnergies, Pau, France

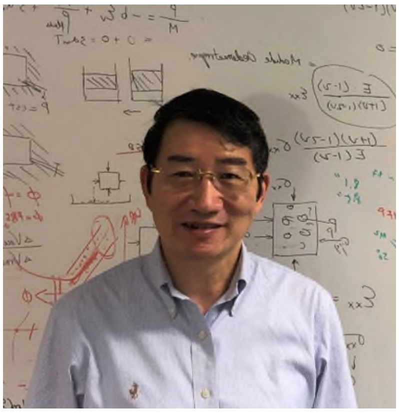
Abstract: In a West Africa offshore O&G field operated by TotalEnergies, the field structural geology is characterized by a high density of normal faults with varying magnitudes of throw, some exceeding 30 meters. Drilling through these faults presents the risk of hole instability near the fault and significant mud losses, i.e., injection into faults. This could induce severe well control problems, sometimes necessitating the drilling of a side-track. In this presentation, we provide an extensive analysis of 232 mud loss events that occurred in 29 wells of the investigated field, considering various drilling parameters and in situ stress parameters. By plotting the stress change acting on the fault planes for each recorded loss event, we analyzed the stress condition of fault hydro-mechanical activation. From this analysis, we proposed a robust law for the value of parameters of the Mohr-Coulomb sliding criterion to predict the potential activation of faults by dynamic mud pressure. This helped us optimize the strategy of mud weight and the well architecture to address the numerous faults.

Characterization of the creeping capacity of a rock from logs data: some in situ cases

Kun SU
OneTech, TotalEnergies, Pau, France

Abstract: There are several thousand wells to plug and abandon in the next decade in TotalEnergies' assets, especially in the North Sea region. Can we consider the cap rock, especially shale or salt, as a natural barrier in case of no cement or poor cement in the annulus? The response to this question has a huge impact on the cost of P&A work, and also on the issue of well integrity of legacy wells for CO_2 storage. In this presentation, we will present the approach developed at TotalEnergies to investigate how to consider cap rock as a natural barrier, including well logs data analysis, lab tests, constitutive models, modelling, and in situ data acquisition by logging and well tests. We present several in situ cases where shale creeping closed the annulus and created effective sealing of the interface rock/casing.

Speaker



Kun Su is the Geomechanics expert in the Drilling & Wells Métier of OneTech, TotalEnergies. Kun joined TotalEnergies in 2008 and was the Head of Geomechanics for Drilling & Wells from 2016 to 2023. Kun has extensive operational experience in Drilling, Completion, and Reservoir Geomechanics, gained from about 600 wells drilled and operated by TotalEnergies in various geological contexts. Previously, Kun was a Geomechanics project manager at the French National Radioactive Waste Management Agency (ANDRA) from 1999 to 2007 and a Rock Mechanics researcher at the École Polytechnique of Paris from 1991 to 1998. Kun obtained a PhD in 1990 and a professorship in 2005. Kun is the author or co-author of 120 papers in international journals and conferences.

Pressuremeter Testing:

A New Formation Test for the In-Situ Measurement of Rock Static Elastic Properties

Thomas Bérard, Geomechanics, Slb

Abstract: Pressuremeter testing (PMT) is a formation test that consists of inflating a cylindrical packer inside a borehole while measuring the radial deformation or injected fluid volume as a function of packer pressure. Provided that the stiffness of the packer measuring system is known and large enough compared to that of the formation, changes in packer pressure associated with changes in injected fluid volume provide a direct, in-situ measurement of the formation static shear modulus at a length scale similar to that of the packer.

Here, we report on the first field-scale campaign of PMTs in deep boreholes performed using a wireline formation tester (WFT) tool. We carried out PMT measurements as part of the characterization and appraisal of potential sites for a deep geological repository for radioactive waste in Switzerland. We successfully performed PMT at six stations spread across four boreholes. The static shear moduli from PMT and laboratory mechanical tests on core sample were consistent, with slightly lower laboratory values. These first results show the viability of the PMT testing technique in deep boreholes with a WFT tool.

Compared to sonic logging and laboratory testing, PMT provides in-situ measurements of rock static elastic properties at a meter length-scale. The testing protocol is straightforward and fast (less than 1h per station). This technique has been standard protocol in soil mechanics for decades and is performed using battle-tested tools. It is shown to be very complementary to sonic logging and stress testing. PMT is a most welcome measurement in softer formations, for which dynamic-to-static correlations are often dubious, as well as in weaker formations, which often suffer from core recovery issues.

Speaker

Thomas Bérard is a Principal geomechanics engineer. He received his PhD in rock mechanics in 2003 from Institut de Physique du Globe de Paris, France. He joined Schlumberger in 2006 as Geomechanics Domain Head for CO2 storage. From 2010 to 2012, he was Senior geomechanics engineer with Data and Consulting Services, based in Pau, France, and from 2013 to 2015, he was Innovation Lead with the Reservoir Geomechanics Center of Excellence, based in Bracknell, UK. From 2015 to 2019, he was a Principal Research Scientist at Schlumberger-Doll Research, Cambridge, Massachusetts. Since 2019, he is Geomechanics Interpretation Manager at Schlumberger-Riboud Product Center, France.

Integration of intrinsic geological heterogeneity in coupled reservoir-geomechanical models for large-scale CO_2 storage

Elisabeth Bemer, Jérémy Frey, Earth Sciences and Environmental Technologies Division, IFPEN

Abstract: Deep saline aquifers play a crucial role in decarbonization strategies, due to their large storage potential. Characterizing the injectivity and long-term integrity of massive CO_2 storage in a deep saline aquifer requires a large-scale 3D numerical model for simulating CO_2 injection and its impact on the geomechanical behavior of the host rock, cap rock and surrounding formations. This numerical model needs to integrate the heterogeneous petrophysical and mechanical properties of the different facies.

An integrated basin modeling workflow has been defined to build a basin-scale numerical model populated in petrophysical and geomechanical properties and simulate different CO_2 injection scenarios in the target aquifer. The first step consists in building a 3D geological model, where each cell is associated with a facies (sedimentary and diagenetic) and petrophysical properties (porosity, permeability). Mechanical properties are then added based on simple phenomenological laws or effective medium models calibrated to experimental and/or log data. Experimental data are acquired on samples representative of the key identified facies using petrographic analysis, porosity and permeability measurements, and petroacoustic and triaxial tests. 3D geomechanical modeling is finally performed to simulate the mechanical impact during the injection phase and the long-term storage.

Speaker

Dr. Elisabeth BEMER has 25 years of experience in the experimental characterization of rock poromechanical behavior. She notably works on the impact of CO_2 injection on the hydromechanical properties of carbonate rocks and specializes in the development of integrated experimental workflows combining geological, petrophysical and geomechanical characterizations. She holds a PhD and an engineering degree from Ecole Nationale des Ponts et Chaussées.

Geomechanics modeling – 1D/3D MEM construction

Andreia Mandiuc, geomechanics engineer, SLB

Abstract: Geomechanics is a key discipline within the energy industry, encompassing the study of the mechanical behavior of geological formations under various stress conditions. Its applications are critical across multiple facets of energy production, including oil and gas exploration, hydraulic fracturing, wellbore stability, and reservoir management. By providing insights into rock mechanics, geomechanics enhances the safety and efficiency of drilling operations, mitigates risks associated with wellbore collapse and sand production, and optimizes hydraulic fracturing techniques for improved resource extraction. Additionally, it plays a vital role in the sustainable management of reservoirs, addressing issues such as compaction and subsidence. In the context of emerging energy solutions, geomechanics is essential for the safe and effective implementation of carbon capture and storage (CCS) and geothermal energy projects.

The implementation of geomechanical studies consists in building a Mechanical Earth Model (MEM) to understand how geological formations deform and sometimes fail in response to various subsurface operations such as drilling, completion, and production.

The construction of a Mechanical Earth Model begins with **data screening**, where available information is collected. Next, **data integration** involves defining a static structural model using geological attributes and single well properties profiles, including mechanical parameters. The **analysis** phase calculates present-day stresses and their evolution over time due to pressure changes, incorporating tectonic loading and pore pressure. Finally, the **applications** phase utilizes results from stress and properties cubes for various well engineering applications, such as well integrity, well placement, drilling integrity, hydraulic fracturing, production, field integrity (including compaction, subsidence, cap rock integrity, and fault reactivation analysis). This workflow ensures robust geomechanical modeling and application, enhancing the safety and efficiency of subsurface operations.

Speaker

Andreia Mandiuc has more than 18 years of experience in the energy sector, and during this period she has been involved in numerous multidisciplinary consulting projects. She holds a bachelor's degree in engineering geology. She also holds a master's degree in Petrology and Metallogeny from the University of Bucharest, Romania. She is currently part of the SLB's Europe geomechanics team, based in Pau, France and is in charge with conducting reservoir geomechanics studies for various applications including field integrity (reservoir compaction and subsidence, faults reactivation, sanding), drilling integrity, new energies (geothermal, ECBM, CCS), underground gas storage or reservoir performance.