KIM MEWS

MASTER OF SCIENCE DEFENSE

PETROLEUM ENGINEERING

Application of Nano-scale Geomechanics Using PeakForce Quantitative Nanomechanical Mapping to Improve Hydraulic Fracture Design in Highly Heterogeneous Reservoirs

The production of hydrocarbons from unconventional reservoirs is nowadays essential to meet the rising the demand for energy in the world. As hydraulic fracturing strongly depends on the principal stresses, the identification of geomechanical properties is key for the assessment of effective hydraulic fracturing design. The assessment of geomechanical properties through macro-scale testing such as true triaxial testing has been performed for decades. However, heterogeneities on a nano-scale in addition to the possibility of having non-intact samples lead to the application of nano-scale geomechanical testing. PeakForce Quantitative Nano-mechanical mapping in atomic force microscopy (AFM PF-QNM) maps the geomechanical properties on a nano-scale requiring a sample size that is as small as drill cuttings. The testing reveals the 3D heterogeneities within the sample indicating spots of highest and weakest strength. This way the anisotropy of the tested material can be assessed.

AFM PF-QNM testing has been performed and compared to the results from performed true triaxial testing for the Eagle Ford Formation. As AFM PF-QNM testing assumes a preset value of Poisson's ratio, an iterative model that solves for Poisson's ratio in dependency of Young's modulus has been developed. In order to reduce the large data set, exploratory factor analysis has been deployed. It determines if unmeasured factors could explain the variance from the data set, which is caused by different minerals, macerals, textures, or pores. These different factors represent groups that are ductile, intergranular or of high strength.

This thesis demonstrates a multi-scale geomechanical comparison for unconventional reservoirs. It improves the evaluation for AFM PF-QNM testing by correcting the Young's modulus iteratively in dependency of the Poisson's ratio. It reveals the advantages of AFM PF-QNM as it can be performed on samples that are as small as drill-cuttings determining the 3D heterogeneity of the material.

Date:

Friday, August 21, 2020

Time:

Starts @ 8:00AM

Zoom Meeting Details:

https://kansas.zoom.us/j/92265655981

Meeting ID: 922 6565 5981

Password: **260103**

Committee Chair:

Associate Professor Reza Barati