GeoConvention
Calgary • Canada • March 7-11 2016
OPTIMIZING RESOURCES

Experience Using Drill Cuttings to Build Geomechanical Models

Ken Glover, Albert Cui, Raphael Wust
Trican Well Service

Summary

Geomechanical models are tools that can be used to improve well and field performance and to reduce associated risks and costs. One such application is using knowledge of geomechanical variability along and around a horizontal well to selectively place hydraulic fracture stages. In theory, we can use these models to predict things such as near-wellbore stress conditions and the behavior of hydraulic fractures during the early stages of pumping a hydraulic fracture treatment. When data is available, a geomechanical well profile can be used to increase the likelihood that fractures will be initiated in locations where fracture initiation and growth will be easiest. These profiles require a sufficiently high-resolution characterization of reservoir quality and of geomechanical properties along the well. Drill cuttings are a potential source of data for construction of a geomechanical model. Options include using routine geochemical analyses (i.e., mineralogy, TOC, and XRF) to indirectly evaluate geomechanical variability, and obtaining direct measurements of rock mechanical properties from drill cuttings through instrumented nano-indentation analyses.

Introduction

In this paper we will look at case study examples where nano-indentation analysis of drill cuttings has been used to build quantitative geomechanical profiles along horizontal wells in the Montney, Duvernay and several other unconventional reservoirs. We describe how variations in stress along these wells were calculated from the geomechanical model built with cuttings data and calibrated to mini-frac, pore pressure and image log measurements where available.

Theory and/or Method

The theory behind the use of nanoindentation to measure mechanical properties has been well documented over the past several decades. Elastic, plastic and viscous mechanical properties can be measured with the right equipment and with sufficient care taken to control the many variables that can influence the measurement. First, a general work procedure is described to derive and validate a geomechanical well profile from nano-indentation on cuttings through some examples of wells with log and core data available. Second, we describe the procedures for constructing geomechanical models based on drill cuttings alone, including a comparison with XRF and mineralogy based proxy models.

Examples

Last, we present examples of optimizing well stimulation with selective fracture stage placement using the geomechanical models built with cuttings-based mechanical and reservoir data. The location of fracture stages along some wells were seen to be located in zones where the model predicted difficulty initiating fractures and creating connectivity to the reservoir.

Conclusions

In these examples our results showed that the drill cuttings mechanical data provided a simpler but more robust description of relevant reservoir geomechanical properties than sonic logging data or geochemical profiling data alone. This allowed for a higher degree of confidence in proposing changes to current operating practices in these reservoirs. In particular, the cuttings-based models could rigorously characterize the mechanical anisotropy of laminated zones in a way that could be tied directly to intrinsic characteristics of a given lithotype such as composition, fabric and texture. These case studies demonstrate that the nano-indentation analysis of drill cuttings can be a reliable and cost-effective part of a geology-based geomechanical assessment of complex and heterogeneous unconventional reservoirs.