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Specifics of mechanical and strength rock properties estimation for wells drilling and exploitation

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Abstract

The paper describes the estimation specifics of mechanical and strength rock properties for well drilling and exploitation. Important processes throughtout oil and gas fields' lifetime (well drilling, exploitation, hydraulic fracturing, etc.) need accurate estimation of current stress state, correct well logs and core data interpretation, position identification of layers intersected by well, etc. The authors of this paper demonstrate problems in the process of coring, core transportation, lab studies, interpretation and usage of experimental data for borehole stability models creation. These models can be used in forecasting hole wall while well drilling and exploitation. Specifics of each step are described, starting with the first vital step in core research workflow – core extracting, and finishing with specifics of hydraulic fracture strength estimation.

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1. Introduction

Mainly, borehole stability depends on the rock properties that well intersects. The precise estimation of mechanical, strength and other rock properties is a successful prediction of well-borehole behavior while drilling,

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fracturing and exploitation (Zoback, 2007). All of these processes are individual and require special attention. A quick and fault-free well drilling is a very complicated process which comes with many fundamental decisions, for example: mud weight fitting, drill head selection, drag force, lack off and circulation losses prediction, rate of drilling, competent interpretation of measurable parameters while drilling (Lukin, 2016). The successful hydraulic fracturing depends not only on the hydrofrac fleet, but also on mechanical rock properties and rock stress state as well. These factors are very important during artificial fracture modeling. The well exploitation process, as a rule, comes with pore pressure shifting, which changes stress field near the borehole. This new stress state around the well leads to the increase of accidents probability (sand production, bridgeover, etc.). The stress state around the borehole is important to predict the borehole behavior (Fjær, 2014). The hole wall is cracking or becoming eroded when pressure in the well is below pore pressure and sloughing or wrecking driven by shear stress when pressure in well below shear fracture gradient. On the other hand, if the well pressure exceeds absorption gradient, techno genetic fractures are arising. The hydraulic fracturing takes place after next following well pressure increasing.

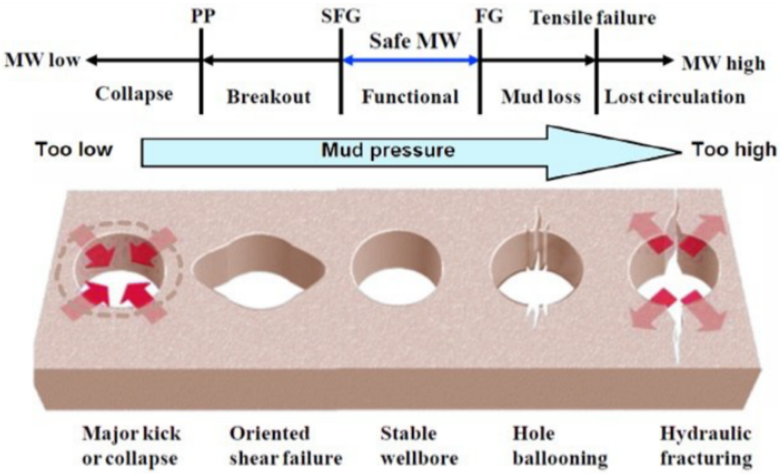

Fig. 1. Schematic correlation of mud pressure (mud weight, MW) and wellbore failures. SFG-shear failure gradient, FG – failure gradient (Zhang, 2013).

All the processes mentioned above need accurate estimation of the current stress state, correct well logs data interpretation, layers that well intersects position identifying, etc. The authors try to analyze the problems of coring, its transportation, carrying out lab studies, experimental data interpretation and usage in the process of borehole stability models creation. These models can be used in forecasting hole wall during wells drilling, exploitation and 1D, 3D geomechanical modelling of reservoirs (Ovcharenko, 2016).

2. Coring

The first important step in the core research workflow is the core extracting. It is needed to minimize coring-induced damage. It is crucial to note the correct core extraction conditions because the coring program infraction may cause core damaging so the following steps may be incorrect or not applicable. The most universal core diameter is 100 mm. The 80 mm diameter core extraction is not recommended.

The coring tool height, used for core extraction, generally varies from 9 to 36 m. The extracted core can damage lower extracted samples by its own weight. That is why the tool height should be matched by the strength rock properties calculation.

The recommended drill rate and bit speed in different types can vary. Minimal rate during core extraction is 1 m/hour. It can also be different according to the target layer depth. The minimum speed values are used in actual practice. On the other hand, there is not only one answer to the question whether a low or high bit speed is preferable for maximum core preservation. In the context of mechanical and strength properties for different types of rock,

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