Use of Drilling Data to Generate Rock Mechanical and Natural Fracture Property Logs in Horizontal Wells

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Abstract

Researchers and engineers have been investigating convenient and cost effective techniques to obtain continuous rock mechanical and natural fracture properties along the wellbore in horizontal wells. The conventional techniques are in many cases expensive, uncertain and sometimes difficult and timeconsuming to process. A convenient system composed of two D-Series software's D-WOB and D-Rock, was developed to generate rock property logs versus depth from available surface drilling data. The D-WOB software calculates effective downhole weight on bit (DWOB) from surface drilling data, drill string information and wellbore survey measurements. The D-Rock software calculates the rock mechanical properties such as, confined compressive strength (CCS), unconfined compressive strength (UCS) and Young's modulus (E) using the outputs from D-WOB software, drill bit information and formation lithogy.

The D-WOB software uses wellbore friction models to estimate the coefficient of friction and effective DWOB from the surface measurement of weight on bit (WOB), hook load, wellbore survey, drilling fluid and drill string information. The software calculates coefficient of friction when the drill string is off-bottom. The estimated coefficient of friction is then used to calculate effective DWOB when the drill bit is on-bottom. The D-Rock software uses rate of penetration (ROP) models developed to estimate rock properties from drilling parameters, such as flow rate DWOB, RPM, reported bit wear, drill bit design parameters.

The D-Series software was verified using field data from horizontal wells in North America. The depth-based and 10 second time-based drilling data along with collected drilling parameters were used to obtain the rock mechanical logs. The UCS rock strength logs were compared to rock strength logs generated from sonic logs with a very good match. The possible natural fractues and fracture zones were identified from a recognized behavior of the rock strengths (UCS) when penetrating the fractures at different depths. The natural fractures were further identified with the corresponding mud losses when drilling the naturally fractured reservoir. The accurate and convenient rock mechnical log from D-Series software and fracture location identification can be used to evaluate well completion strategies efficiently and in a cost-effective way.