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LWD Calipers for Hole Condition Monitoring During Drilling and Completion

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ABSTRACT

Logging While Drilling (LWD) derived calipers (ultrasonic, density, and resistivity) have been available for several years, but their utilization is still limited due to the belief that they are not as reliable as the mechanical calipers obtained from wireline (WL) logs. One possible reason for this belief is the different time at which the LWD and WL measurements are made. The different timing means that the WL provides the latest measurements describing the most recent state of the wellbore. However, LWD density derived calipers have their advantages over the WL calipers. One example is that they cover relatively larger portion of wellbore circumference, thereby providing a better characterization of borehole shape. A 3D caliper image can be obtained using 16 radii density measurements around the wellbore. Another advantage is that these measurements are available in real-time and borehole deterioration with time can be measured with time lapse acquisition. Accurate logging-while-drilling (LWD) derived caliper data are important for drilling, logging and well completion. An accurate LWD derived caliper can greatly minimize risk and improve quality by bringing critical new information to these applications. During drilling, caliper data can be used to monitor the wellbore condition, providing early warning of borehole washout and impending wellbore instability, thus allowing the driller to make remedial action. During well completion, the caliper data can be used to accurately evaluate the volume of cement required to fill the casing annulus as well as aiding in determining the depths for casing points or packer intervals by identifying in-gauge hole intervals. During logging, a reliable caliper is essential to correct some formation evaluation measurements for borehole size and to evaluate the quality of almost all LWD logs. A caliper can be used to plan services (such as formation testers) that may be affected by unfavorable borehole conditions.

In this paper, the main objective is to characterize the change in wellbore shape with time and relate it to formation characteristics and drilling and completion operations. Any relationship observed and correlated will be utilized to optimize the practices within these operations.
The methodology undertaken to perform this analysis follows these steps: first, LWD density derived calipers were acquired in two phases: while drilling time and pull out of hole (POOH). This is done to characterize the borehole deterioration with time. Second, the time-lapse LWD density measurements were processed to obtain 8 arm calipers. Third, the 8 arm LWD calipers were then compared quantitatively to 4 arm WL mechanical calipers acquired after well was drilled to total depth (TD) based on an in-gauge criterion. The WL mechanical caliper measurement is used to evaluate the accuracy of the latest (POOH) LWD density derived caliper. Finally, based on comparison, the well behavior was divided into three distinct groups, and their main characteristics are discussed.