Adverse Effects of Poor Mud Cake Quality: A Supercharging and Fluid Sampling Study

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Wireline Formation Testers (WFT) are routinely used at discrete depths of a well to collect reservoir fluid samples and to estimate undisturbed reservoir pressures, near-wellbore formation permeabilities, fluid compressibilities, and saturation pressures. A pressure profile in the vertical direction yields fluid densities and fluid-contacts (GOC and WOC) in the reservoir. Reliable results are obtained when the mud cake isolates the wellbore from the formation. When mud cake cannot provide isolation, mud filtrate invasion continues and supercharging occurs. The issue of sample quality becomes critical when using oil-based muds because the filtrate is also oil and is difficult to separate from the formation oil, a pure sample of which is needed for fluid characterization studies. This study investigated the effects of poor mud cake seal on sample quality and formation test data and its analysis when oil-based muds are used. Modeling studies were conducted using a finite element simulator.

The results of the study indicate that mud cake permeabilities need to be less than one microdarcy and mud cake to formation permeability ratios need to be less than 10^{-4} to achieve sample qualities higher than 90%. Conditions such as high pumpout rates, low overbalance pressures, and shallow filtrate invasion depths improve sample quality. The presence of a permeability-damaged zone around the mud cake improves sample quality but reduces the sampling pressure. The Formation Rate Analysis (FRA^{SM}) technique estimates formation permeability accurately in the presence or absence of supercharging. The formation pressure estimated using the buildup data is the pressure at the mud cake-formation interface. The supercharged pressure must be subtracted from the apparent formation pressure to obtain the true formation pressure. A simple procedure is developed for estimating the mud cake permeability and the supercharged pressure. Supercharged pressure is shown to be a product of the apparent overbalance pressure, mud cake to formation permeability ratio, and an invasion factor representing the distance up to which supercharging extends.