Wellbore Instability in Shales: A Review of Fundamental Principles, Physico-Chemical Mechanisms in Mud-Shale Interaction and GRI-Funded Research

Gas Research Institute
Report Number GRI-99/0025.3
December, 2000

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Abstract:

Wellbore instability issues in shales are a source of serious problems in drilling and completion operations. The principal objective of this investigation is to review recent research efforts funded by GRI that were directed towards enhancing the industry's understanding of the complex physico-chemical interactions between shales and drilling muds. The fundamental principles of wellbore instability are summarized, including the mechanical effects of mud density and wellbore wall coating additives on near-wellbore stresses and rock yielding or failure. Based on the results of the GRI-funded research pertaining to physico-chemical mechanisms, the ability of shales to act as semi-permeable membranes when exposed to water-based and oil-based drilling fluids was demonstrated to be of critical importance. The effects of ionic flow on wellbore stability were also observed to be important. Experimental data demonstrating these processes are summarized, and the practical consequences of pore pressure changes induced by osmotic flow through shale membranes for wellbore instability are discussed. Other important physico-chemical mechanisms discussed include the observed decrease of shale strength when exposed to certain drilling muds, and the effects of shale hydration on near-wellbore stresses and swelling strains. The recent research efforts have been successful in identifying new water-based muds that can improve shale stability.

AGI 50-073