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Experimental Tests of Guarded-Probe Sampling

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The drilling process usually introduces foreign fluid into subterranean formations. This fluid contaminates samples taken from the formations. To minimize contamination, wireline sampling tools remove much more fluid than would be necessary in the absence of contamination. The most sophisticated sampling tools monitor contamination and retain only the least contaminated part of a sample. The extended time required to obtain a quality sample is costly and increases the risk that the tool will stick in the well. Consequently, methods for obtaining quality samples faster have great value.

An important candidate for reducing sampling time is guarded-probe sampling. This method is analogous to focusing of borehole electrical measurements. The guard part of the probe surrounds the sample probe and draws fluid from the formation so that the fluid entering the sample probe comes from points deeper in the formation. With a guarded probe, the total volume of fluid (guard plus sample combined) that must be removed in order to obtain low contamination may be several times smaller than with conventional methods.

This paper reports a series of laboratory experiments performed to study the guarded-probe concept in two dimensions. For these experiments, glass beads contained in a thin, transparent cell form the porous medium. The “original” pore fluid is an optical index-matching oil. The foreign (“invasion”) fluid is the same oil with a dye dissolved in it. Samples are prepared with invasion fluid near one edge of the cell and clear fluid elsewhere. Sampling ports on that edge withdraw fluid at controlled rates. Clear fluid enters the cell from the opposite edge. A camera records the displacement of the dyed fluid by the clear fluid and the dye concentration is measured in production

flow lines. The experiments test the concept for miscible fluids in two dimensions. For a variety of conditions and even for inhomogeneous permeability, the experiments verify that a guarded probe produces clean samples of original pore fluid much faster than a simple probe can. A commercial reservoir simulator successfully models the experiments without adjustable parameters.