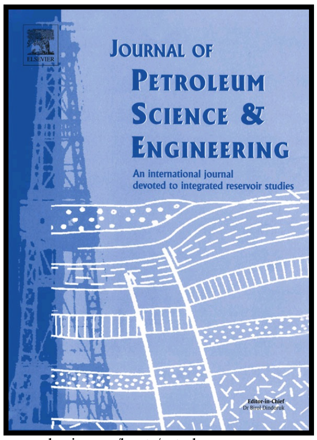

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Effects of mix-wet porous mediums on gas flowing and one mechanism for gas migration

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Abstract

Mixed wetting pores commonly develop in oil and gas sandstone reservoirs and affect the percolation behavior of multiphase flows; thus, these pores represent a key problem that is frequently addressed in studies on hydrocarbon migration and accumulation and oil recovery enhancement. This paper aims to determine the effects of oil-wetting pores on gas migration in a mixed porous medium. We have conducted gas migration experiments in mixed wetting bead models saturated with water in which the beads were composed of oil-wetting and water-wetting beads. Nuclear magnetic resonance is employed to investigate the migration processes and elucidate the mechanisms under which gas flows freely in mixed wetting pores. The experimental results indicate that the likelihood of gas migration driven by buoyancy increases with the fraction of oil-wetting grains in the mixed wetting models as a logarithmic function. Gas migrates spontaneously in mixed pore media with more than 60% oil-wetting beads. Oil-wetting pore throats that are mainly composed of oil-wetting grains also improve the dynamic conditions that favor the migration of gas phase. The connectivity of oil-wetting pore throats in the vertical dimension is critical for the free migration of gas in mixed wetting porous media. Gas can only invade porous media by spontaneous imbibition after sufficient oil-wetting components are available to form a continuous pathway for the nonaqueous phase. Early oil emplacements have been widely identified in low-permeability sandstone reservoirs of various gas plays, and they can lead to wettability alterations of some grain surfaces. The creation of mixed wetting conditions may offset the decreased reservoir quality for late gas migration in terms of nonaqueous fluid flows.

Keywords: mixed wettability; gas migration; imbibition; low-permeability reservoir; nuclear magnetic resonance.

1. Introduction

Wettability is a fundamental reservoir property as the same as porosity and permeability, and has a strong influence on the microscopic flow and distribution of fluids (Anderson, 1986; Morrow, 1990; Buckley, 1996). For reservoirs with low physical property (porosity less than 10% and permeability lower than 0.1 mD), wettability plays a particularly critical role in the migration and accumulation of oil and gas (Zeng et al., 2014; Luo et al., 2016). Wettability refers to the relative adhesion of two fluids to a solid surface, and the wettability of a system can range from strongly water wet to strongly oil wet depending on the brine-oil interactions with the rock surface (Craig, 1971). Furthermore, if no preference is shown at the rock surface for either fluid, then the system is considered to exhibit neutral wettability or intermediate wettability. Clastic reservoirs that were initially deposited in brine and present rock surfaces adhered with an aqueous film are regarded as originally strongly water wet. Nevertheless, reservoir rocks consist of a variety of mineral types,