New Thoughts on Improving Oil Recovery within the Muddy Sandstone at Kitty Field and Beyond, Powder River Basin, Wyoming

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Abstract

The Lower Cretaceous Muddy Sandstone has produced in excess of 300 million barrels of oil in Wyoming from stratigraphic traps formed within the complex geometries of the various members of the formation. Despite the importance of this reservoir, our understanding of the Muddy is limited and has resulted in less-than-optimal recovery practices. Many fields producing from this formation, such as Kitty Field, have yet to be waterflooded due to incompatible injection fluids that adversely affect the in situ clays. Many of those fields that have been successfully waterflooded have underperformed. As a result of these shortcomings, significant recoverable oil reserves are left stranded in many Muddy reservoirs. In order to improve recovery efficiency within the Muddy, two factors need to be addressed. The first is conducting detailed reservoir characterization to better understand flow unit distribution. The second factor is to determine economically compatible fluids which can be used for secondary recovery in those fields that have proven to be sensitive to injection fluids. New work suggests that the currently accepted model for deposition of the Muddy Sandstone is not universally applicable and has led to miscorrelations of the various members within the Muddy, which in turn has resulted in inefficient hydrocarbon recovery strategies. The accepted model for Muddy deposition in the Powder River Basin assumes the existence of a major unconformity between the Muddy and the underlying Skull Creek Shale, manifested by local incised valleys. According to this model, these valleys were backfilled during Muddy time by fluvial sands that grade upward into those of increasingly marine influence, until finally being conformably overlain by the Shell Creek Shale (lowest beds of the Mowry Shale). Instead of valley incision into the underlying Skull Creek Shale, new work at Kitty Field indicates that episodic dissolution of the underlying Permian Ervay Salt caused local subsidence in the strata during late Skull Creek time, which formed depressions that were then in-filled by sands and shales now attributed to the Muddy Sandstone; there was little to no incision. Correlations of each member within the Muddy must take into account a possible changing structural datum caused by the salt dissolution. In addition to improving correlation methods, work is being initiated by the Enhanced Oil Recovery Institute to develop a brine compatible with the problematic reservoirs within the Muddy. This work is currently focusing on treatments that can be made to the injection fluid most commonly used for reservoirs within the Muddy, i.e. water derived from the Upper Cretaceous Fox Hills Formation.