

The Upper Mancos Shale in the San Juan Basin: Three plays, Conventional and Unconventional*

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Abstract

The Mancos Shale (Upper Cretaceous) covers approximately 12,000 mi² in the San Juan Basin of northwestern New Mexico and southwestern Colorado. From its outcrop belt around the flanks of the basin, the Mancos dips into the subsurface of the basin. The basin is structurally asymmetric with a gentle southern flank and a steep northern flank. Depth to the top of the Mancos exceeds 6500 ft. along the basin axis.

The Mancos is subdivided into two formations, the Upper Mancos Shale and the Lower Mancos Shale, which are separated by an unconformity. The Upper Mancos Shale has been productive of oil and natural gas from both conventional and unconventional reservoirs. The Upper Mancos Shale is 900 to 1600 ft. thick in the San Juan Basin. It is thinnest along the southwestern flank of the basin and gradually thickens to the northeast.

There are three plays in the Upper Mancos Shale: the *Tocito marine bar play*, the *Naturally fractured Mancos Shale play*, and the *Offshore Mancos Shale play*. The *Tocito marine bar play* is a conventional play productive of oil and associated gas from sandstones in the lowermost part of the Upper Mancos Shale. The reservoirs are northwest-southeast-trending shoestring sandstones on the southern flank of the basin; they were deposited offshore of and parallel to the paleoshoreline. Most of the reservoirs were discovered in the 1950's.

The *Naturally fractured Mancos Shale play* is a conventional play located along the southeastern and northwestern flanks of the basin. In these areas, Laramide tectonic uplift that formed the present-day basin outline initiated fracturing of the more brittle lithologies within the Upper Mancos Shale. The open fractures resulted in prolifically productive reservoirs that have been exploited by vertical wells.

The *Offshore Mancos Shale play* is located northeast of the Tocito marine bars. This is the modern unconventional play within the basin. This play extends northeast from the Tocito marine bars into the axial part of the basin. Almost all production and recent exploration is within the lowermost 400 ft of the Upper Mancos Shale (the Mancos C interval). Reservoir intervals are organic-rich marine shales with laminations and very thin beds of very fine-grained sandstones and siltstones. Percentage and thickness of sandstone beds decrease to the northeast with

increasing distance from the paleoshoreline. Current and recent exploratory wells have been drilled horizontally as well as vertically and stimulated with multi-stage hydraulic fracturing.

The Upper Mancos shales are both the source rocks and the reservoirs in the *Offshore Mancos Shale play*. Along the southwestern flank of the basin Upper Mancos shales are thermally immature. Peak oil generation was attained along a trend just northeast of the Tocito marine bar reservoirs. The transition from the oil window to the wet-gas window occurs 8 to 10 miles northeast of the Tocito marine bar reservoirs. The dry gas window is present in the northern part of the basin. Total organic carbon (TOC) content of Mancos C shales ranges from 0.5 to 3.2%. Oil-prone kerogens are dominant in the majority of samples.

Introduction

The San Juan Basin of northwestern New Mexico (Figure 1) has produced natural gas and oil since 1921. Production has been dominantly gas and natural gas liquids. Oil has been produced from relatively small reservoirs. Primary reservoirs have been Upper Cretaceous blanket sandstones with limited permeability and, beginning in the 1990's, Upper Cretaceous coal beds. Oil has been produced primarily from northwest-southeast-trending Tocito shallow marine to marginal-marine sandstones of Late Cretaceous age on the southwestern flank of the basin. These oil reservoirs pass northeast into marine Mancos shales. Mancos shales have produced large volumes of oil from naturally