

Development of the Bone Spring Sandstones in Loving County and adjacent areas: Part 1 Bone Spring Sandstones

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Three different zones within the Permian Leonardian Bone Spring formation in Loving County are excellent drilling and completion objectives. Historically, vertical Bone Spring wells in Loving County have been marginal to noncommercial. In fact, the Bone Springs formation has historically produced less than 1 million barrels in all of Loving County. This talk examines the excellent potential for future production from the Third Bone Spring sandstone, the First Bone Spring sandstone, and the Avalon Shale at depths ranging from 11,600 feet to 7000 feet.

The Bone Spring formation in Loving County is approximately 2600 to 3200 feet thick. It has been historically subdivided into six informal units, the First, Second and Third Sandstones, overlain by the First, Second and Third Carbonates. The Bone Spring reaches a maximum thickness in easternmost Eddy County (T25-26S, R31E) extending south into west central Loving County. This depositional axis is 20 miles west of the current structural axis located in SE Lea extending into eastern Loving County. The structural axis at the base of the Bone Spring (top of Wolfcamp) was a result of Tertiary tilting of the Delaware Basin and therefore does not locate the site of maximum Bone Spring deposition.

The Third Bone Spring sandstone is 325 feet thick in Loving County thinning from a depocenter over 400 feet thick also along the Eddy/Lea County line. The Third Bone Spring Sandstones appears to have been deposited from the north and northeast from the shelf into the Delaware basin. Production occurs from multiple (typically four to six), relatively thin (2 to 15 ft thick) individual very fine grained sandstones encased in tighter siltstones and shaly siltstones. In the productive trend, net pay (> 12% porosity) totals 20 to 50 feet. Notably, individual sandstone beds can be traced across all of Loving County, but the beds get shalier and tighter on the distal west side of the county.

Data suggests the Third Bone Spring sandstone will produce in Loving County in between three key Third Sandstone fields found to date: (1) the Red Hills field in SENM (12.6 MMBO, 25 BCFG, 11.2 MBW) and the War Wink and War Wink S. fields (collectively over 23 MMBO) in Winkler and Ward Counties to the SE. In 1997, Scott Montgomery postulated that the Third Sandstone would continue to be present, be over-pressured and produce in Loving County in the 25 mile gap between these fields. To date, four main lines of evidence further support this hypothesis. Core data shows a similar residual oil saturation in the Haley field relative to data from War Wink. Second, a key test (Bold Leiman 10#1) in between these fields confirms the Third Sandstone is over-pressured and flows with a 35 to 40 % oil cut. Third, mapping data shows clean Third Sandstone beds are present with a depocenter maxima of 40 ft or greater ss>12% porosity in east central Loving County. Last several other key vertical tests, plus numerous wells with excellent mud log shows suggest the horizontal development of the Third Sandstone is hydrocarbon bearing and should extend over much of eastern Loving County. Of course, the key new thing is the evolution of horizontal drilling and completion technology.

Prolific horizontal drilling of the Third Sandstone has rapidly expanded the play stratigraphically away from the War Wink and War Wink S fields. Estimated ultimate recoveries of 400 to 600 MBOE/well have been cited by Anadarko, the most prolific driller of this play. Currently twenty rigs are drilling laterals in this play, in Ward (12), Reeves (6), Loving (1) and Winkler (1) counties with Anadarko(5), Energen(4), Chesapeake(3), and Cimarex (3), currently most active. There have been approximately fifteen Third Sandstone laterals drilled so far in Loving County. The best recent Loving County Third Sandstone wells drilled to date are the Anadarko Blacktip Johnson 39#1 which initially produced 1100+ BOPD in April, 2010 and has produced 183 MBO and 259 MMCFG in 11.5 months so far; and (2) the Chesapeake Johnson 76#1 which has produced 49.5 MBO and 158 MMCFG in four months and currently produces 370 BOPD. The First Bone Spring sandstone produces commercially from depths of 10150 to 10180 feet in two key eastern Loving County wells, the Manzano (Patterson) Bowdle 42#2 Estate and the Manzano Haley 43#2. These two wells have produced 468 MBO and 840 MMCFG from 15 to 20 ft of net sandstone with 20% porosity. Production occurs where the First Sandstone is relatively clean (GR<60), has greater than 14% porosity (up to 24%), has good mudlog shows, and calculates productive. Like the Third Sandstone, the First Sandstone is significantly overpressured in Loving County; the Haley 43#2 well had original pressure of 6875 psi at 10150 ft.

Recent Morrow drilling by Chesapeake and Anadarko in the Haley field provides key information to suggest the trend may expand to cover a significant portion of eastern Loving County. Logs suggest net pay may be as thick as seventy feet. Mapping suggests the First Sandstone was deposited as submarine fan deposits along a NNE-SSW axis. The presence of the net pay section varies widely and appears channelized. In general it tracks over Third Sandstone productive trends and lies beneath potentially productive Avalon shales to provide a third key Bone Spring objective. To date no one has tried a horizontal well in the First Bone Spring in Loving County, although they are now common in New Mexico. Given the results so far, the First Sand, where found may be an excellent vertical up hole secondary objective to add to horizontal Third Sandstone wells. Combining the isopach maps of the First and Third sandstones shows an excellent multipay trend in east central Loving County. In western Loving County, where porous, logs and mud logs suggest the First Bone Spring is generally water-bearing, and may be a consideration when deciding where to place a lateral in the overlying Lower Avalon.

References: Permian Bone Spring Formation; sandstone play in the Delaware Basin; Part I, Slope By Scott L. Montgomery, *AAPG Bulletin*; August 1997; v. 81; no.8; p.1239-1258

Permian Bone Spring Formation; sandstone play in the Delaware Basin; Part II, Basin By Scott L. Montgomery *AAPG Bulletin*; September 1997; v. 81; no. 9; p. 1423-1434