

**PROPOSED STRATIGRAPHIC CORRELATION FRAMEWORK,  
WOLFCAMP OF DELAWARE BASIN, WEST TEXAS**

The Wolfcampian sequence of the Delaware basin, West Texas, can be subdivided into five stratigraphic units, using log character, basin-wide correlative marker beds, lithology, and paleontology. All five units are productive of oil and gas. These proposed units are based on multiple cross section networks using over 5000 raster logs, over 900 mud and sample logs, and 62 wells with paleontological data. The geographic extent and thickness of each stratigraphic unit was governed by geometry of the basin in post Pennsylvanian time. Lithology was governed by proximity to Wolfcampian carbonate shelf edges which rimmed the basin on the northwest, north and east, by a siliciclastic source from the southwest, and from the Ouachita thrust belt to the south. Erosion of older, Pre Wolfcampian stratigraphic units at the margins of the basin is documented by paleo data. The five stratigraphic units fit within a sequence stratigraphic framework and document a sea level highstand, lowstand and highstand from Early to Late Wolfcampian time.

The units are as follows, in depositional order from base Wolfcamp to top Wolfcamp:

The Haley Unit is a shale and thin bedded carbonate debris deposited at the very base of the Wolfcamp sequence, overlying Pennsylvanian (Atoka through Cisco) "Starved Basin" Shales. This unit varies from 60 to more than 2000 feet thick and is thickest in central Reeves County in a trough north of the EW trending Grisham Arch and south of the EW trending underlying Atoka Bank in northern Reeves and Loving Counties. The Haley Unit can be defined on the log as a coarsening upward/fining upward sequence of thin bedded shales and carbonate debris beds. Its top is marked either by a shale marker (possible sealevel highstand marker) or sharp erosional contact with the overlying unit. In New Mexico the Haley Unit is thin-bedded, high gamma ray shales, indistinguishable from the underlying Pennsylvanian shales, except by paleo data. Over 190 wells produce from the Haley Unit; first significant production was established from vertical wells completed in the Haley Field of southeastern Loving County in 1997.

The Debris Unit consists of several different clastic lithologies overlying the Haley Unit, and varies in thickness from 75 to over 1900 feet. A siliciclastic deposit is located in Culberson and Reeves counties in a trough north of the EW trending Grisham Arch and south of the EW trending underlying Atoka Bank. Here, sandstone and siltstone lowstand fans, with a sharp basal contact, were sourced mostly from the south and southwest from the converging Ouachita thrust belt. In Eddy County, New Mexico, coarse grained to fine grained carbonate debris flows were deposited locally with an erosional basal contact. On the east flank of the Delaware Basin in Lea, Winkler, and Ward Counties, the Debris Unit holds large carbonate debris blocks containing reworked Strawn fusulines. In the southeastern corner of the Delaware basin a very large debris block of Mississippian limestone (at least 16 square miles and 1000 feet thick) slid westward from the Central Basin Platform and landed in an overturned fold (documented by the Clayton Williams El Chato well) in the bottom of the Delaware basin, like a napkin falling from a tabletop. The top of the Debris Unit can be defined on logs by a basinwide shale marker, probably a sea

level highstand marker. It is proposed that this Debris Unit is time equivalent to the Wolfcampian sea level lowstand and erosion surface found to the east on the Central Basin Platform, to the west on the Diablo Platform, and represented by the Powwow Conglomerate, but further work is needed to establish that relationship. Over 250 wells produce oil and gas throughout the basin from the Debris Unit.

The Red Hills Unit conformably overlies the Debris Unit and consists of a coarsening upward/fining upward sequence, up to 1500 feet thick, of thin bedded shale and carbonate debris deposited in a deep basinal setting. Its top is defined over much of the basin by a very distinct correlative basin wide shale marker which is interpreted to be a maximum flooding surface, marking a sea level highstand at the end of Red Hills time. Over 500 wells produce throughout the basin from the Red Hills Unit, from vertical and horizontal wells. However, first significant production was established in 1962 in the Red Hills Field in southern Lea County New Mexico where the Red Hills Wolfcamp discovery well has produced more than 2 MMBOE.

The Ford West Unit conformably overlies the Red Hills Unit, and consists of thin bedded siliceous shale and carbonate debris beds from 50 to 1600 feet thick, demonstrating on the log a coarsening upward/fining upward sequence. The Ford West Unit's base is the distinct, basin wide maximum flooding surface shale marker, and its top is defined over much of the basin as by distinct correlative limestone bed. The Ford West unit produces oil and gas throughout the basin from over 1000 wells, including from the Phantom and Wolfbone field areas and from both vertical and horizontal wells, but first significant production was discovered in 2011 by Cimarex in Culberson County in the Ford West Field.

The Phantom Unit conformably overlies the Ford West unit, is up to 775 feet thick, and consists of thin bedded organic rich shales and carbonate debris beds deposited in a fining upward sequence and characterized by a high resistivity signature. The Phantom Sands A, B, and C are three thin siltstone units contained within the top of the Phantom Unit, and are probably genetically related to the Third Bone Spring Sand. Phantom C extends from the north into southern Eddy County, Phantom B extends as far south as Loving County, and Phantom Sand A extends from New Mexico as far south as Ward County. The top of the Phantom Unit (equivalent to top of the Wolfcamp) is a mappable shaly marker throughout the Delaware Basin and defines the base of the Leonard or Third Bone Spring Sand. The Phantom Unit, both the carbonate/shale unit and the siltstone units, produces throughout the basin from over 1200 wells. The majority of completions are horizontal wells in the Phantom field of Ward and Loving Counties (discovered in 2002), but there are also many vertical completions from the Phantom Unit in the Wolfbone Trend (discovered in 2010) in eastern Reeves County.