Geologic Controls on Production in Low-Permeability (Tight) Sandstones in the Pennsylvanian Cleveland Formation, Northwest Anadarko Basin

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Although gas production from the low-permeability (tight) Cleveland Formation in the northwest Anadarko Basin dates from the late-1950's, relationships between productivity and sequence-stratigraphic and facies controls on reservoir geometry have not yet been fully characterized. Analysis of closely spaced log sections from a dataset containing ~1,130 wells from Ochiltree and Lipscomb Counties, Texas, and Ellis County, Oklahoma, and five (5) conventional cores with ~250 ft (~75 m) of section indicates that the Cleveland Formation is a succession of highstand tidally modified shelf, lowstand incised-valley-fill, and transgressive deposits that accumulated on a broad shelf. Distribution of the greatest producing wells in the Cleveland Formation is controlled mainly by gross-sandstone thickness and facies geometry that varies within three systems tracts. Lower Cleveland production trends reflect northeast-trending, tidally modified shelf sandstones within highstand system tracts. These sandstones are eroded by an east-west trending, lowstand incised-valley and estuarine system. The greatest number of producing wells in the middle Cleveland Formation coincides strongly with this incised-valley-fill system. In contrast, upper Cleveland sandstone bodies deposited in a transgressive systems tract, are much thinner than those in the underlying middle Cleveland lowstand, and therefore are less favorable hydrocarbon reservoirs. Other controls on Cleveland productivity include the regional Lips fault, southeast-plunging anticlines, and structural noses presumed to be associated with fracture-enhanced permeability. Future development in the Cleveland Formation should take into account the depositional evolution and systematic variations in sandstone bodies in each systems tract that controls the orientation and distribution of maximum permeability pathways.