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West Texas (Permian) Super Basin, United States: Tectonics, structural development, sedimentation, petroleum systems, and hydrocarbon reserves

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ABSTRACT

The West Texas (Permian) Super Basin is the prototype super basin. The basin has produced 28.9 billion bbl of oil and 203 TCF of gas (63 billion BOE, 1920–2019). The US Geological Survey and Bureau of Economic Geology estimate this super basin has remaining reserves of 120–137 billion BOE, twice the volume produced during the first 100 yr of hydrocarbon production. During the past decade, the West Texas Super Basin has been the driver of production growth in the United States and has decades of remaining economic production and reserve growth.

The West Texas Super Basin is a complex Paleozoic basin built on a varied Proterozoic crust. After Cambrian rifting, regional subsidence began in the Middle Ordovician and continued into the Devonian, forming the Tobosa Basin. The early Paleozoic Tobosa Basin subsidence terminated during Mississippian epeirogenic uplift. A later stage of subsidence began in the

Late Mississippian accompanied by large-scale faulting and moderate folding. This tectonic and structural development was controlled by basement terrains, earlier tectonic, and structure reactivated by compression of the Ancestral Rocky Mountains and Marathon-Ouachita orogenic events. These formed the Permian Basin. The Marathon-Ouachita tectonic event ended in the Wolfcampian (early Permian). Subsidence continued to the end of the Permian (Ochoan). Periodic subsidence during the Mesozoic was likely caused by Rocky Mountain (Laramide) deformation. Cenozoic (late Paleogene–Neogene) western uplift tilted the basin to the east. Each of these events has a significant influence on the basin petroleum systems.

The basin has multiple source rocks and petroleum systems formed during various stages of basin development. During the formation of the early Paleozoic Tobosa Basin, Simpson Group and Woodford Shale source rocks were deposited. During the transitional basin development phase, the Barnett Shale source rocks were deposited, and during Permian Basin subsidence, the Wolfcamp and middle Permian (Leonardian and Guadalupian) source rocks were deposited. Continued subsidence into the Mesozoic resulted in the deposition of additional strata. These Mesozoic intervals are now mostly eroded but provided sufficient burial depths for thermal development and increased the extent of thermal effect for maturation and migration of hydrocarbons within these Paleozoic petroleum systems.

Leonardian and Guadalupian conventional reservoirs have produced 71% of the resources from all conventional West Texas Super Basin reservoirs. These reservoirs are typically most abundant on the shelf crest (shelf to edge), where reservoir development is maximized and becomes a focus of hydrocarbon migration from the deeper Delaware and Midland Basins source rocks and shallower, more-proximal shelf and platform source rock systems.

Unconventional resource reservoir oil production in the West Texas Super Basin accounted for just under 90% of total basin daily production at the close of the last decade (2010–2019). Total West Texas Super Basin production peaked in March 2020 at 4.7 million BOPD. Since that time, production has declined because of lower rates of investment driven by lower product prices.

The West Texas Super Basin economic oil and gas production has benefited from an extensive infrastructure, a large geologic and engineering community, regulatory and public support, open access, sufficient capital availability, and a scalable service industry. The paradigm toward new drilling, completion, and production technology has been driven by

unconventional resource reservoir development in the basin. These West Texas Super Basin technological developments have lead industry technology for unconventional resource development worldwide. Maintaining talented human resources and capital are challenges that time will tell if individual firms and the industry will meet to develop the hydrocarbon resources within the basin.

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