Anadarko Petroleum Corporation

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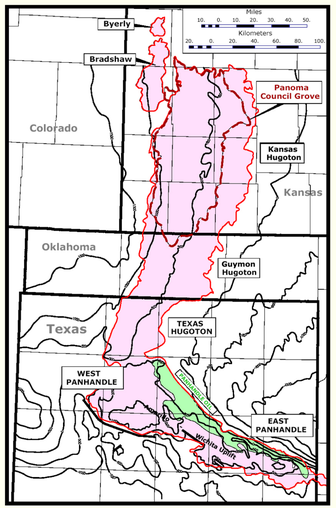
ABSTRACT

Panhandle-Hugoton, the largest North American gas field, has long been controversial because of inconsistent fluid contacts, commonly attributed to hydrodynamic flow despite the absence of an up-dip aquifer, and extreme subnormal pressures. These anomalies are addressed in terms of a basin-scale petroleum system history, largely independent of the geographically underlying pre-Permian system.

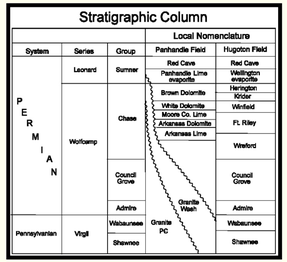
The deep Anadarko Basin was generating hydrocarbons during Early Permian carbonate deposition, with efficient southward migration from all potential source rocks via bounding faults and Pennsylvanian-Permian alluvial fans. Giant Amarillo Uplift drape structures trapped hydrocarbons immediately following Permian evaporite deposition. The pre-Laramide Panhandle Field, at maximum pressures of 1500-2500 psi, contained most of the oil and gas now found in Midcontinent Permian reservoirs.

The Early Tertiary Laramide orogeny redistributed Panhandle Field fluid columns, possibly spilling the first gas northward into the Hugoton Embayment. Subsequent erosion of Permian reservoir facies in eastern Kansas allowed water discharge to outcrops at elevations much lower than the regional hydraulic head. As regional pressure dropped in response, the Panhandle Field gas cap expanded rapidly, forcing a Late Tertiary-Quaternary mass movement of gas northward to fill Hugoton and associated fields.

Panhandle-Hugoton reservoir pressures (435 psi at +100') are normal relative to outcrop elevations of <1000', negating the need for exotic theories to explain superficially subnormal conditions relative to burial depth (>2500'). Variations in fluid contacts, pressure, and gas composition suggest that reservoir fluids are still moving, with driving forces resulting from decompression and the rapid volumetric expansion of a supergiant gas accumulation.



Wolfcamp Structure and Stratigraphic Column after Pippin (1970)



PANHANDLE - HUGOTON FIELD

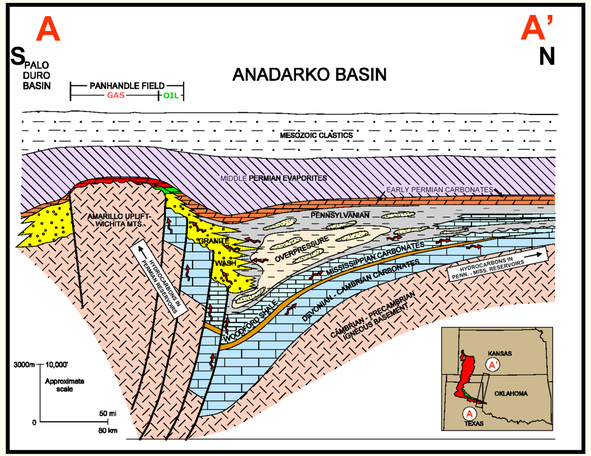
Panhandle-Hugoton is the largest gas field in North America, with an EUR > 75 TCF, and the world's largest source of helium. The oil rim on the northern, Anadarko Basin, side of the Panhandle Field has an EUR of 1,400 MMBO.

Panhandle-Hugoton is one of the largest reservoirs in the world in terms of area (8000 square miles) and hydrocarbon pore volume (> 1,000,000,000,000 barrels).

Gas production in Panhandle-Hugoton, for regulatory purposes, is divided into Kansas Hugoton, Guymon (Oklahoma) Hugoton, Texas Hugoton, West Panhandle, and East Panhandle Fields.

Bradshaw, Byerly, Panoma Council Grove, and other large Permian gas fields share a common genetic origin with Panhandle-Hugoton, and can be considered part of the same supergiant gas accumulation.

Scientific controversy has surrounded these fields because of the extreme subnormal reservoir pressures (435 psi @ 2500-3000 feet) and variations in the fluid contacts and gas composition.



Cross Section after Johnson (1989), Dutton & Garnett (1989), Pippin (1970)

ANADARKO BASIN

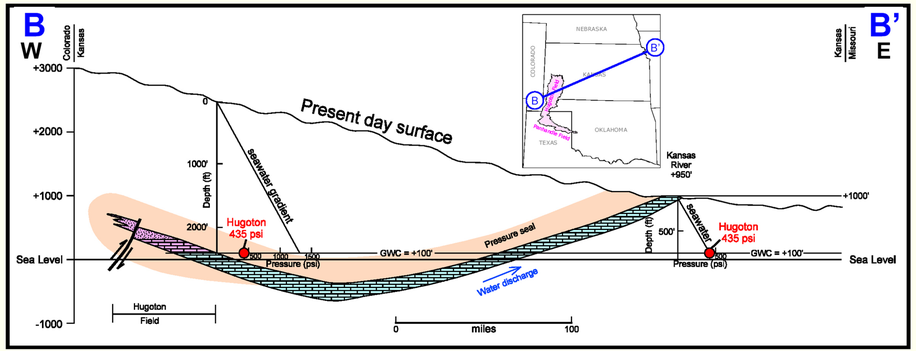
Rapid burial of numerous Anadarko Basin source rocks provided a large hydrocarbon charge during the Late Pennsylvanian-Cretaceous time period. Hydrocarbons generated in the deep Anadarko Basin followed efficient southward migration pathways, up bounding faults and "Granite Wash" alluvial fans, to the early Panhandle Field structural traps

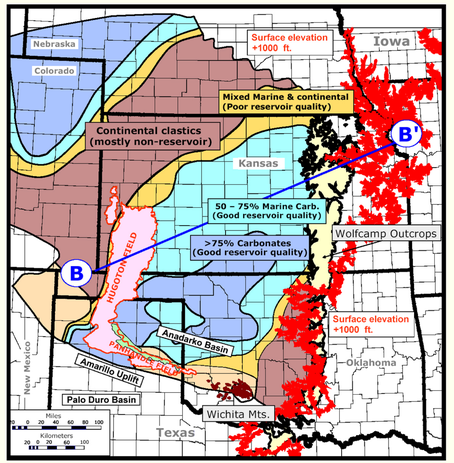
Early Panhandle field drape structures trapped oil & gas immediately following burial of Early Permian reservoirs under Middle Permian evaporites

Panhandle-Hugoton must have been charged from pre-Permian sources, as significant Permian source rocks have not been documented within the Anadarko Basin

Pennsylvanian-Mississippian reservoirs of the Hugoton Embayment were charged by northward migration up the Anadarko Shelf. The near total absence of oil in Kansas Permian reservoirs indicates that vertical migration from underlying oil-rich Pennsylvanian and Mississippian reservoirs was not a major charge mechanism for Hugoton

Deep crustal, abiogenic, sources have been proposed for the Panhandle Field by Gold & Held (1987), and at minimum are responsible for some of the helium. Any contribution from this mechanism would have been mixed with organically-sourced hydrocarbons from the deep Anadarko Basin prior to gas cap expansion.





Upper Wolfcamp facies after Rascoe (1988)

PANHANDLE-HUGOTON PRESSURE

Panhandle-Hugoton reservoir pressures are extremely subnormal relative to burial depth, 435 psi @ 2500-3000 feet

All published studies assume that Panhandle-Hugoton was originally at a normal pressure gradient, prior to the Early Tertiary Laramide orogeny

Panhandle-Hugoton is at a normal pressure gradient relative to the surface elevation of eastern Kansas reservoir outcrops

Although the distance from the Hugoton Field to the outcrop, approximately 175 miles, appears to be a long distance to expect reservoir continuity, it is actually small relative to the 275 mile length of the Panhandle-Hugoton accumulation

The regional reservoir pressure history of the Wolfcampian carbonates had a major impact on the formation of the oil and gas accumulations in the Permian of the western Anadarko Basin