A Dynamic Model for the Permian Panhandle and Hugoton Fields, Western Anadarko Basin

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Panhandle-Hugoton, the largest North American gas field, has long been controversial because of extreme subnormal pressures, variable gas composition, and “tilted” fluid contacts, commonly attributed to hydrodynamic flow despite the absence of an effective up-dip aquifer. 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 gas into the Hugoton Embayment. Subsequent erosion of Permian reservoir facies in eastern Kansas allowed water discharge to outcrops at elevations below 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, driven by decompression and the rapid volumetric expansion of a supergiant gas accumulation.