AAPG Search and Discovery Article #90048 © 2005 AAPG Mid-Continent Section Meeting, September 10-13, 2005, Oklahoma City, Oklahoma

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.

Hydrocarbons were already being generated in the deep Anadarko basin during the Early Permian, 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 burial depth and pressure, contained most of the oil and gas now found in Mid-Continent 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 pressures upon discovery were subnormal relative to drilling depth, but normal relative to reservoir outcrop elevations in eastern Kansas, indicating that pressures are controlled by aquifer communication with the surface rather than burial depth. 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.