Accommodation Model for Wolfcamp (Permian) Redbeds at the Updip Margin of North America's Largest Onshore Gas Field

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Purpose:

To determine the accommodation and stabilization mechanisms that led to a lateral transition between Permian marine-carbonate-dominated sequences and continental-siliciclastic-dominated sequences at the margin of a giant gas field.

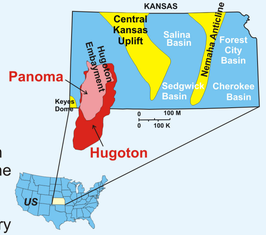
In the Kansas portion of the Hugoton Embayment of the Anadarko Basin, Council Grove Group red silts and very fine-grained sands of probable continental origin are up to four times thicker updip than they are in the middle to outer portion of the gently dipping ramp. Interbedded with the siliciclastics are shoaling-upward marine carbonates, the principal gas reservoirs in the fields, that were deposited during times of high sea level on the low-relief shelf. Carbonate units thin to the northwest where the red siliciclastics are thickest. A few of the carbonate units pinch out where the siliciclastics thicken in a position nearly coincident with the field margin. The redbeds have been suggested to be the lateral seal for the field and understanding the mechanisms for depositing the siliciclastics high on the shelf is critical to understanding reservoir geometry of the largest onshore gas deposit in North America.

Major Points:

- Much continental siliciclastic accumulation in the Council Grove results from biostabilization (plant and animal-induced) rather than by accommodation related to sea-level rise
- Continental siliciclastics of eolian origin built relief that reduced accommodation for marine carbonates at the updip field margins
- Continental siliciclastics are not a lateral seal for the Panoma Field even though the field margin is coincident with pinchout of marine carbonates
- There is a predictable succession of continental lithofacies controlled by the interaction of climate, glaciation/de-glaciation, and sea level

Approach:

1. Describe and analyze thirteen cores of the Council Grove in the Hugoton-Panoma field area.
2. Tie lithofacies to wireline electric well logs.
3. Utilize the Kansas Geological Survey tops set (formation-member level) from 12,000 wells to map thickness of each sedimentary half cycle (marine carbonate-siliciclastic) in the Council Grove.
4. Develop general depositional model to explain sedimentary patterns.



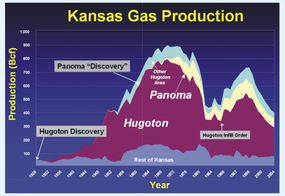
Mechanisms considered for deposition of siliciclastics:

1. Siliciclastics are marine and accumulation is related to accommodation by sea level rise.
2. Siliciclastics are fluvial (alluvial). Accommodation is from a rising gradient over a low relief surface.
3. Siliciclastics are eolian and stabilized by rising water table associated with rising sea level.
4. Siliciclastics are eolian and stabilized by a rising water table associated with increased rainfall due to a climate change.
5. Siliciclastics are eolian and accumulation was made possible through biostabilization from plants and animals.

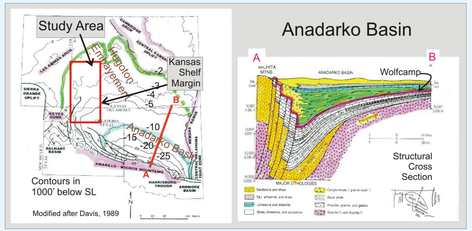
Field History:

The 70-year old Hugoton and Panoma Field has yielded 34 TCF gas from the Wolfcampian Chase and Council Grove Groups. In the center of the field the combined gross pay is up to 130 meters thick (430 feet) and production is from thirteen fourth-order marine-continental sedimentary sequences. The two fields, Hugoton (Chase) and the underlying Panoma (Council Grove), have been regulated separately, but the two are more likely a common reservoir.

KANSAS	Hugoton	Panoma	Combined
Discovery	1928	1958	
Development	1948	1970	
Infill Drilling	1990	?	
Depth	2,500	2,750	
Wells	7,536	2,345	9,881
Cum. Gas (TCF)	24.7	3.0	27.7
BCF/well	3.3	1.3	2.8
Annual (BCF-2003)	239.9	62.5	302.4
MMCF/Well	31.8	26.7	30.6



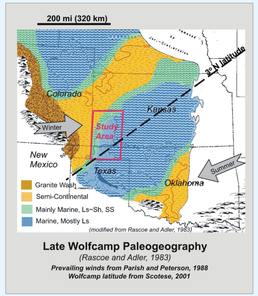
Geologic Setting



Hugoton and Panoma Fields are situated in the Hugoton Embayment, the shallow shelf portion of the Anadarko basin, and asymmetric foreland basin associated with the Ouchita-Marathon Orogeny.

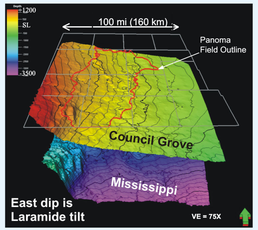
By Wolfcamp time the Pennsylvanian-aged Anadarko was nearly completely filled and slopes on the Kansas shelf were extremely low.

Glacially driven eustatic sea level changes resulted in fourth order marine-continental (carbonate-siliciclastic) sedimentary cycles on the Kansas shelf during Wolfcamp.



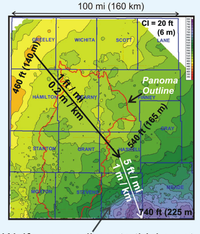
Late Wolfcamp Paleogeography
(Rascoe and Adler, 1983)
Prevailing winds from Parish and Peterson, 1988
Wolfcamp latitude from Scotese, 2001

Present Day Structure



Wolfcamp Isopach

Chase to Roca Shale
(most of Wolfcamp)

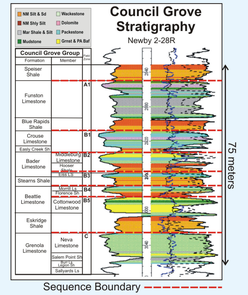


Wolfcamp sediments thicken at the steepened slope position near the Kansas shelf edge

Stratigraphy

System	Series	Group	Field
Permian	Leonardian	Sumner	
	Wolfcampian	Chase	Hugoton, Byerly, Bradshaw
		Council Grove	Panoma
Pennsylvanian	Virgilian	Admire	
		Wabaunsee	Greenwood
		Shawnee	

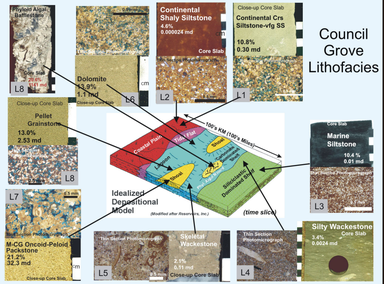
Panoma gas production is from the upper seven marine-continental, carbonate-siliciclastic, fourth-order sedimentary sequences in the Lower Wolfcamp, Council Grove Group. The overlying Hugoton produces from the Upper Wolfcampian Chase.



Council Grove Lithofacies

Shown are eight major lithofacies (L1 – L8) for the Council Grove and idealized depositional model that is a time slice (not intended to show progradation). Eight classes can be broadly lumped into three categories:

- Marine rocks having a mud-supported texture (L3-4-5)
- Reservoir facies in the marine rocks, those having grain supported textures (L7-8) and dolomite (L6)
- Continental redbeds (primarily silts, L1 and L2).

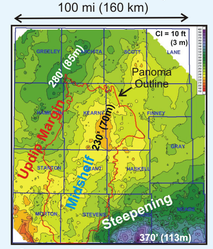


Dubois, Byrnes, Bohling, Seals and Doveton, 2003

The Big Picture:

Unusual Kansas shelf sedimentary patterns

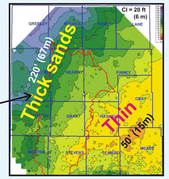
Three maps: Gross thickness, net marine and net continental from seven cycles



Council Grove isopach

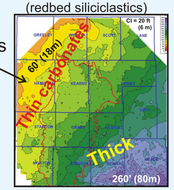
Thickest where shelf steepens marginal to Anadarko Basin and at west updip margin of Panoma, coincident with pinchout of marine carbonates. Thinnest at midshelf.

Thick eolian sands



Net continental isopach (redbed siliciclastics)

Carbonates pinchout



Net marine isopach (mostly marine carbonate)