Wolfcamp Platform Carbonate and Basinal Facies in the Midland Basin

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Outline

- Geological Setting
- Wolfcampian platform carbonates
- Wolfcamp basinal facies in the Midland Basin
- Summary
Geological Setting

After Fu et al., in press
Compiled stratigraphic chart showing proposed fusulinid-based correlations of the Wolfcampian secession in the Permian Basin. Four third-order depositional sequences (NR1 to NR4 in the Nealian Stage) and three third-order sequences (LH1 to LH3 in the Lenoxian Stage) were identified within the Wolfcamp carbonates in Glass Mountains. Seven third-order Wolfcampian sequences (composite sequences) were recognized in Central Basin Platform (WS1 to WS7).
2nd-order sequence boundaries (unconformities) and sea-level changes (After Markello et al., 2008)

Timing, duration and character of the late Paleozoic Ice Age, and estimated maximum magnitude of glacioeustatic fluctuations (Modified from Rygel et al., 2008; Fielding et al., 2008). Dark gray boxes in the maximum magnitude section are common values; light gray boxes represent the size of are events.
2nd-order sequence boundaries (unconformities) and sea-level changes (After Markello et al., 2008)

3rd-order sequence boundaries (After Haq & Schutterr, 2008)
Stratigraphy

(A) West-east cross section of the Wolfcampian strata in the Northwest Shelf (Modified from Silver and Todd, 1969).

(B) Cross section showing lithofacies and stratigraphic architecture of the Wolfcampian in the North Platform, Midland Basin (Modified from Mazzullo and Reid, 1989).

(C) Generalized dip stratigraphic cross section of the Wolfcampian, showing depositional systems, and progradation and aggradation of Eastern Shelf (Modified from Brown et al., 1990).

After Fu et al., in press
Lithofacies in the subsurface of Central Basin Platform

(1) bioclast grainstone and grain-dominated packstone; (2) ooid grainstone, bioclastic peloidal grainstone and grain-dominated packstone; (3) bioclast mud-dominated packstone and wackestone; (4) bioclast–algal boundstone; (5) Peloidal/oncoidal algal wackestone; (6) fusulinid packstone and wackestone; (7) lime-mudstone and argillaceous lime mudstone; and (8) shale.

Core slabs of Wolfcamp “Reef” interval from well Unocal Parker X-1. Core photos courtesy of Arthur Saller.
Central Basin Platform

(A) Bioclastic peloid grainstone with abundant interparticle porosity (ip). 8748.4 ft.

(B) Bioclastic grainstone with intragrain pores. Dominant grains are crinoids and bryozoans.

(C) Boiclastic-peloid packstone with abundant interparticle and intragrain pores. 8735.2 ft.

(D) Algal bioclast packstone with interparticle and moldic vugs. 8650.7 ft.

These facies commonly occur in the upper parts of individual cycles.

All samples are from the well Unocal Andrews Parker X-1.

After Fu et al., in press
Central Basin Platform

(A) bioclast peloid packstone with interparticle and intragrain pores. 8733.7 ft.
(B) bioclast packstone. Glauconite is relatively abundant. No visible pores. 6834.8 ft.
(C) Bioclast Wackestone. Major grains include crinoids, brachiopod, and bryozoans. No visible pores. 8655.8 ft.
(D) Argillaceous lime-mudstone. 87 59.3 ft.

All samples are from the well Unocal Andrews Parker X-1. These facies commonly occur in the middle to lower parts of individual cycles

After Fu et al., in press
Photomicrographs of stained thin sections from the Wolfcamp “reef” intervals in the well Unocal Andrews Parker X-1. (A) Abundant vugs (blue areas) are present in bioclast packstone, and interpreted to result from dissolution of skeletal grains and minor micritic matrix. 8679.0 ft. (B) Voids are lined by early non-forran calcite cement (nf) and then filled with late forran calcite cement (fc). 8752.3 ft.

The main diagenetic processes that affected porosity evolution in the Wolfcamp “reef” interval were dissolution, and calcite cementation. Fabric-selective dissolution of grains created moldic pores, and nonfabric-selective dissolution created vugs. Dissolution is interpreted to be related to subaerial exposure.

Core photos courtesy of Arthur Saller.
Wolfcamp stratigraphy, cyclicity, and facies distribution in University Block 9 field area, based on image logs. Three gamma-ray log markers can be reasonably well correlated. (After Ruppel, 2001).

Columnar section showing depositional facies and cycles of the Wolfcamp “reef” interval, based on cores from Unocal Parker “X” #1. Reservoir intervals occur in the middle part and the lower portion of the upper part of the Wolfcamp “reef”. The core depths have been shifted by correlation to Gamma-ray (after Fu, 2009).
Model for deposition of a typical cycle in the Wolfcampian “reef” interval. (After Saller et al., 1999).

Depositional cycles and stratigraphic sequence in the platform margin of the Central Basin Platform (Modified from Candelaria et al., 1992).

Dip oriented (west-east) sequence stratigraphic framework in the eastern Central Basin Platform (After Candelaria et al., 1992).
### Wolfcamp basinal lithofacies based on cores

<table>
<thead>
<tr>
<th>FACIES</th>
<th>COMPOSITION</th>
<th>DEPOSITION</th>
<th>PRODUCTION</th>
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<tbody>
<tr>
<td>Sandstone Siltstone</td>
<td>very fine sand coarse silt</td>
<td>Turbidite</td>
<td>Reservoir</td>
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<tr>
<td>Carbonate Packstone &amp; wackestone</td>
<td>lithoclasts bioclasts</td>
<td>Turbidite &amp; Debris flow deposits</td>
<td>Reservoir</td>
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<td>Reservoir Source Rock</td>
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<td>Laminated Siltstone</td>
<td>silt organic carbon clay</td>
<td>Hemipelagic</td>
<td>Reservoir Source Rock</td>
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<tr>
<td>Siliceous Mudrock</td>
<td>silt, clay organic carbon carbonate</td>
<td>Hemipelagic</td>
<td>Reservoir Source Rock</td>
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Modified from Hamlin and Baumgardner, 2012
<table>
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<td>Lower Leonard</td>
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Wolfcamp Type log

Central Mildland Basin

Siliciclastic
Calcareous
Carbonate

From Hamlin, 2015
North-south cross section in the Midland Basin

- Siliciclastic
- Calcareous
- Carbonate

From Hamlin, 2015
Regional west-east cross section C-C’, showing Lower Permian stratigraphy and lithology in central part of Midland Basin. Gamma-ray and resistivity log curves are the basis for lithofacies interpretations presented here.

After Hamlin and Baumgardner, 2012
West-east cross section in the Midland Basin

From Hamlin, 2015
Wolfcamp Isopach map

From Hamlin, 2015
(After Markello et al., 2008)
summary

- Cyclicity is evident in the eastern Central Basin Platform. Individual cycles commonly have shales, argillaceous lime-mudstone or fusulinid wackestone packstone at the base or lower part of cycles. The upper part of individual cycles contains abundant grainstone and grain-dominate packstone facies, which is good reservoir rocks. Algae are one of most important sediment producer, and algal buildups facies are common in the Wolfcampian of Eastern Central Basin Platform.

- In the Wolfcamp carbonates of eastern Central Basin Platform, the most significantly diagenetic processes are dissolution and cementation, and dolomite has not observed in the samples. Many samples from subsurface of eastern Central Basin Platform contain abundant visible pores (including interparticle pores, vugs, molds, and intragrain pores).
On the basin floor, sandstone, siliceous mudrocks interbedded with carbonate packstone/wackestone and calcareous mudrocks. The lower Wolfcamp interval forms a west- and north-thinning wedge of siliciclastics derived from tectonic source areas to the east and south. During sea-level lowstands, platforms were exposed, and siliciclastic sediment was transported directly into the basin.

Carbonate wackestone/packestone and calcareous intervals is inferred to have formed as highstand systems, which are composed of hemipelagic deposits (siliceous mudrocks and calcareous mudrocks) and detrital carbonate gravity-flow deposits. During transgressive and sea-level highstands, flooded platforms became carbonate factories, and sediment input to the basin comprised platform-derived carbonate and hemipelagic (windblown) sediments.

By flooding or exposing the wide platforms, sea-level fluctuation controlled sediment input into the basin.
Acknowledgement

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Thank you for your attention