Contrasting Siliciclastic-Dominated Cores from the Middle Pennsylvanian (Desmoinesian) Strawn Group, East Kent County, TX: Wallace Ranch #1 and #2

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Abstract

The Wallace Ranch #1 and #2 cores (Kent County, Texas) span 90 feet of mudrocks, heterolithics, sandstones, conglomerates, and carbonates from the Strawn Group (Middle Pennsylvanian - Desmoinesian) on the Eastern Shelf of the Midland Basin. This short core workshop focuses on reservoir characterization of these two cores spanning the same reservoir interval by integrated detailed digital core description, thin section and scanning electron microscope petrography, X-ray fluorescence, and X-ray diffraction datasets. Reservoir properties vary across stratigraphy – and between the two cores - with depositional components and near-surface diagenetic features overprinted by burial diagenesis.

Both cores are largely comprised of heterolithic siltstone and sandstone that transition upwards into bioturbated sandstones, then back to heterolithic siltstone and sandstone. Burrows (Asterosoma, Palaeophycus, Planolites, Skolithos, Scolicia, etc.) are abundant and change in character across this transition. These sediments are interpreted as representing shifts upwards from prodelta, delta front, tidally influenced delta bar, and deltaic subtidal flat environments across 4th-order (cycles ~100-400ky) sea-level highstand. Deltaic sediments are capped with an erosional surface in both cores, however the Wallace Ranch #1 core contains conglomerates, sandstones, intraclast rudstones, and sandy skeletal grain-dominated packstones above this erosional surface. These sediments are interpreted to have formed as an incised valley fill deposited during sea-level lowstand. Both cores are capped with calcareous claystone rich in organic matter (OM), which are interpreted to have been deposited during transgression after deltaic and carbonate sedimentation drowned.

Porosity is most abundant in deltaic siliciclastics, especially in bioturbated fine- to medium-grained sandstones interpreted to have been deposited in tidally influenced sand bars. Pores are primarily interparticle, however moldic, clay-hosted, and intraparticle porosity is common as well. Poikilopic Fe-carbonate cements are common, especially under the incised valley fill in Wallace Ranch #1. Compaction through burial occluded large volumes of porosity, especially where ductile clay and mudrock grains are abundant. Quartz cement is common, less so in more argillaceous sands. Moldic porosity occurs predominantly where feldspars dissolved. Porosity is minimal in OM-rich mudrocks that cap the cores – occurring as sparse clay-hosted, moldic, and patchy OM-hosted pores in kerogen.
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Depositional Setting

- Middle Pennsylvanian (Desmoinesian ~308-306.5 Ma) equatorial (~8 to 10°S) and tectonically active epicontinental basin
- Eastern shelf of the Midland Basin
- Overall 2nd-order cyclicity, pronounced high-frequency cyclicity (<~100-400ky) due to icehouse climate conditions
- Cyclic deposition of marginal marine, deltaic, and alluvial siliciclastics interbedded with carbonates and basinal mudrocks
- Siliciclastic sediments sourced from the East, prograded to the West

Modified from Wright, 2011

Blakey, 2020
Depositional System

- Marginal-marine and deltaic siliciclastics prograded to the W during SL highstand, commonly capped with lowstand incised valley fill
- Lowstand channel deposits incising into underlying prodelta & deltaic deposits.

Wright, 2008 (after Cleaves, 1993)
Dataset

- Wallace Ranch #1 and Wallace Ranch #2 cores (1.5 miles apart) from Kent Co. Texas – about 90ft of section
- Detailed (1 to 24 scale) digital core descriptions with interpretation of sequence stratigraphy and depositional environments tied to literature
- 361x handheld XRF scans and modeled mineralogy (~4x per foot)
- 10x XRD spectra and modeled mineralogy
- 10x thin sections
- 10x ion-polished FE-SEM
Key Facies

- OM-rich calcareous claystone
- Heterolithic sandy claystone
- Heterolithic argillaceous sandstone
- FG-MG sandstone
- Quint-sand skeletal GDP
### Distal epicontinental basin

<table>
<thead>
<tr>
<th>Incised valley fill</th>
<th>Bar (tidally influenced)</th>
<th>Deltaic (delta front)</th>
<th>Prodelta</th>
</tr>
</thead>
</table>

### Deltaic (subtidal flat?)

<table>
<thead>
<tr>
<th>Bar (tidally influenced)</th>
<th>Deltaic (delta front)</th>
<th>Prodelta</th>
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</thead>
</table>
Wallace Ranch #1

Major Oxides (wt. %)

Trace Elements (ppm)

Wallace Ranch #2

Major Oxides (wt. %)

Trace Elements (ppm)
Trace Fossils

- Planolites
- Asterosoma
- Paleophycus
- Vertical Spreiten
Trace Fossils & Depositional Setting

Carmona et al. 2009

Burrowing Intensity + Diversity
Cryptic lithic LFG sandstone – Facies 3

- Quartz sand
- Lithic grains
- Interparticle $\phi$
- Poikilotopic carbonate
- Crushed mudrock grain
SEM images (A, C-D) & EDS (B) map of “Area 2” from 6551.1 feet in the Strawn Formation in the #1 Wallace Ranch core.

- **A**: Biotite
- **B**: EDS map
- **C**: Interparticle φ
- **D**: Quartz sand
- **Clay**
Heterolithic argillaceous VFG sandstone - Facies 6

Sprieten in vertical burrow

Fe-carbonate

Carbonate

Quartz overgrowths

SCAN, FOV=27x45mm

2.5x, PPL

20x, XPL
SEM images (A, C-D) & EDS (B) map of “Area2” from 6569.1 feet in the Strawn Formation in the #1 Wallace Ranch core.

A: Clay-hosted φ
B: K-feldspar
C: Quartz sand
D: Chlorite (?)
Bioturbated OM-rich calcareous silty claystone – Facies 8
SEM images (A, C-D) & EDS (B) map of “Area 1” from 6524.6 feet in the Strawn Formation in the #1 Wallace Ranch core.

- A: Kerogen, Quartz silt, Chlorite, Micrite, Moldic φ(?)
- B: Map of “Area 1” showing elements Si, Ca, Al, Mg, Na, K.
- C: Micrite, Porous kerogen
- D: Clay-hosted φ

Micrite

Kerogen

Quartz silt

Chlorite

Moldic φ(?)

Clay

Porous kerogen
Summary

• Two cores (Wallace Ranch #1 and #2) 1.5 miles apart from a sand body in the Middle Pennsylvanian (Desmoinesian) Strawn Group on the Eastern Shelf

• High-frequency (4th-order ~100-400ky) cyclicity strongly influenced the system resulting in:
  – Marginal-marine tidally-influenced deltaics during highstand
  – Erosion and incised valley fill during lowstand
  – OM-rich calcareous claystone during transgression

• Sandstones contain common to abundant interparticle meso- micro-porosity and clay-hosted micro-porosity
  – Strongly impacted by compaction of clay and lithic grains; carbonate, clay, and quartz mineralization

• OM-rich calcareous claystones contain sparse clay-hosted, moldic, and patchy OM-hosted micro- and nano-porosity
References


Let’s look at the rocks!