Late Quaternary Climate Changes on the Central High Plains Recorded in Playa-Lunette Systems

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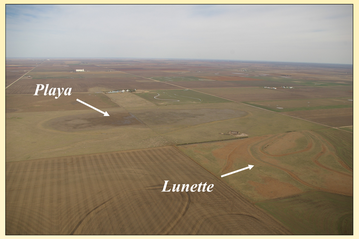
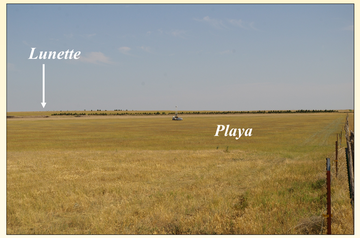
Playa-Lunette Systems on the Central High Plains of Kansas

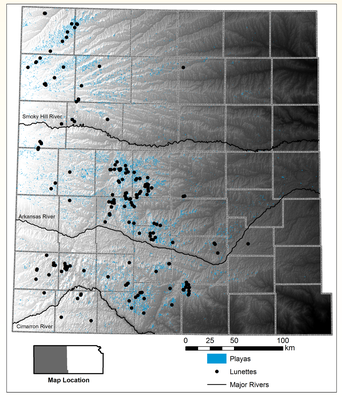


Oblique aerial view of playa-lunette system



Ground view of playa-lunette system. Drill rig located near playa center. Lunette appears as a low ridge along the horizon.

- Playa-lunette systems (PLS) are common features of semi-arid and arid regions around the world
- Playas are relatively small, ephemeral, depressional wetlands
- Lunettes are isolated dunes that form along the margins of some larger playas
- Lunettes consist of material deflated from playas and regional uplands
- PLS are influenced by fluvial, lacustrine, and eolian processes, with the dominant process at a given time dependent on prevailing environmental conditions
- Due to the small size and ephemeral nature, playas are sensitive to climate fluctuations
- As a result, PLS provide a record of local- to meso-scale climate change



- Approximately 22,000 playas have been identified and mapped on the Kansas High Plains based on a variety of geospatial data layers
- Recently, lunettes were mapped for 46 counties in western Kansas
- Lunettes were identified on 1:24,000-scale digital raster graphics as isolated ridges associated with playas
- 135 playa-lunette systems (PLS) have been identified in Kansas
- 105 PLS consist of a single playa and single lunette
- 30 PLS consist of multiple lunettes associated with a single playa or multiple playas in close proximity

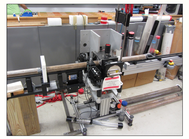
Field Methods

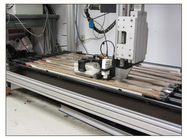
- Cores were collected from six sites in four counties: Lane (3), Clark, Thomas, and Finney using a Giddings hydraulic coring machine
- All sites in Lane and Clark counties consisted of a playa and lunette; sites in Thomas and Finney counties consisted of an isolated playa without an associated lunette

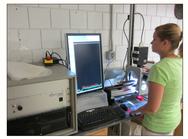
Laboratory Methods

National Lacustrine Core Facility (LacCore)

- Bulk density was measured on whole cores using the Gamma Ray Attenuation and Porosity Evaluator (GRAPE) method
- Cores were split using a band saw and core faces were cleaned
- Split-core analyses at 0.5 cm intervals included Geotek-mounted:
  - Magnetic susceptibility using a Bartington MS2E point sensor
  - Spectral color using a Konica-Minolta spectrophotometer





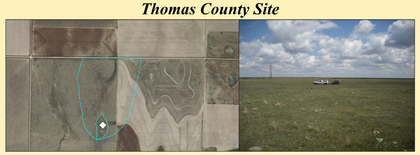


- Samples were collected in 1 - 10 cm intervals for stable carbon analysis
- Buried soils were sampled for AMS radiocarbon analysis at the National Ocean Sciences Accelerator Mass Spectrometry Facility

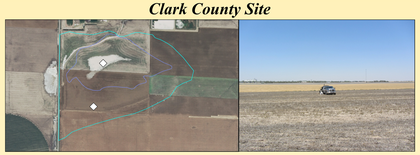
Playa-Lunette System Research Sites

Finney County Site

Thomas County Site



Clark County Site



Lane County Site 2

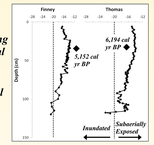
Lane County Site 3

Lane County Site 11

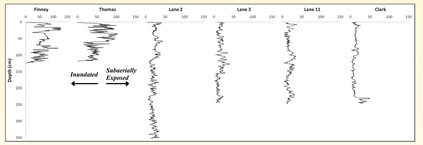
Late Quaternary Climate Change Recorded in Playa-Lunette Systems

Stable Carbon Isotopes ($\delta^{13}C$) - Playas

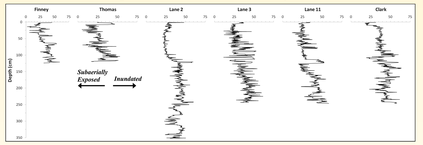
- *$\delta^{13}C$ values within playas indicate flood frequency and duration - more negative values indicate prolonged periods of standing water, less negative values indicate subaerial exposure*
- *$\delta^{13}C$ values within lunettes indicate regional climate - more negative values indicate cooler/moister conditions, less negative values indicate warmer/drier conditions*



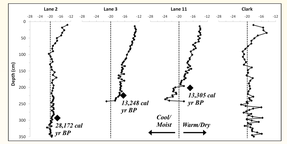
Magnetic Susceptibility (χ) - Playas



Spectral Color (L*) - Playas

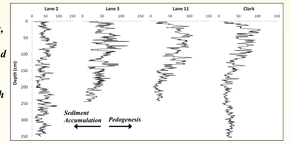


Stable Carbon Isotopes ($\delta^{13}C$) - Lunettes



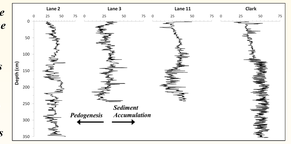
Magnetic Susceptibility (χ) - Lunettes

- *χ is depleted during saturated conditions and repeated wet-dry cycles, so χ values within playas indicate relative changes in flood frequency and duration*
- *Enhanced χ values are associated with greater precipitation and pedogenesis, so χ values within lunettes indicate relative changes in precipitation*



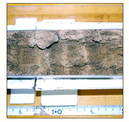
Spectral Color (L*) - Lunettes

- *L*, the lightness value within the CIELAB color system, aids in the ID of stratigraphic boundaries*
- *L* values are higher for gleyed deposits samples, so L* indicates relative change in playa flood frequency and duration*
- *L* values are typically lower for darker samples, so L* indicates degree of pedogenesis in lunettes*



Interpretation & Summary

Playas are dominated by several-meter-thick deposits of gleyed clays.



Lunettes are dominated by several-meter-thick accumulations of weakly developed soils with A-C profiles.

Playa	Zone	Depth (cm)	$\delta^{13}C$	^{14}C Age	SD	Calendar Age	SD
Lane 2	Lunette	297	-19.8	23,500	220	28,172	283
Lane 2	Lunette	627	-19.8	24,400	320	29,201	413
Lane 3	Lunette	231	-18.7	11,400	80	13,248	101
Lane 11	Lunette	207	-21.8	11,450	75	13,305	95
Clark	Lunette	580	-14.0	28,500	230	33,889	281
Clark	Lunette	680	-15.5	32,800	1,300	38,180	1,300
Finney	Playa	33	-14.3	4,490	35	5,152	95
Thomas	Playa	63	-16.1	5,380	30	6,194	40

- Stable carbon isotope data indicate that throughout the Late Quaternary playas were primarily subaerially exposed and dominated by non-wetland vegetation; $\delta^{13}C$ data within lunettes indicate that warmer/drier conditions prevailed throughout much of the Late Quaternary.
- However, magnetic susceptibility data indicate that playas experienced periods of prolonged inundation by water as evidenced by much lower χ values within playas compared to lunettes. χ values within lunettes are oscillatory, suggesting droughts were common between wet intervals.
- Spectral color, with higher L* values within playas, also indicates that playas experienced periods of inundation long enough for playa soils to become gleyed. L* values within lunettes are highly oscillatory, suggesting periods of prolonged drought followed by periods with sufficient moisture to support dense vegetation and promote pedogenesis.

Acknowledgements

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