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Reconstructing Past Landscape Change from Sand Grains: Coral Pink Sand Dunes, Utah

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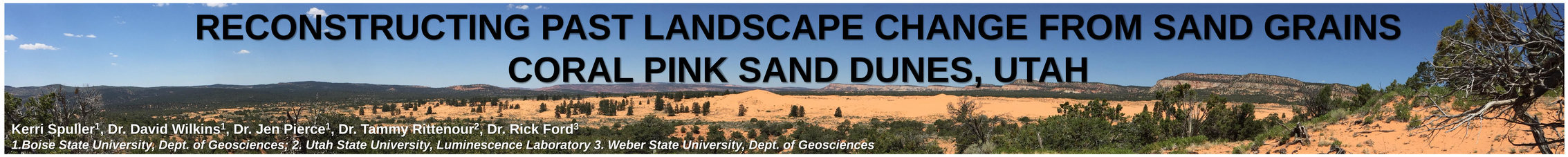
Abstract

This study investigates aeolian, i.e. wind-blown, deposits preserved in the Coral Pink Sand Dunes, Utah. Deposits are dated with optically stimulated luminescence (OSL) to determine when aeolian activity has occurred in the past. Deposit ages are compared to paleoclimate records to understand how climate controls on aeolian activity have changed over time. New OSL ages from this study provide the first evidence of aeolian activity during the last major interglacial period for the Colorado Plateau. Understanding how these landscapes responded to past climate variability is important for predicting how they will respond to projected climate change.

RECONSTRUCTING PAST LANDSCAPE CHANGE FROM SAND GRAINS
CORAL PINK SAND DUNES, UTAH



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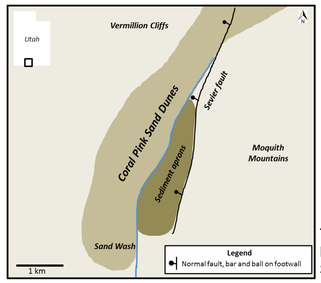
How does climate change influence landscapes?

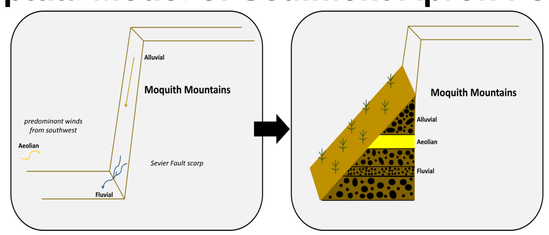
Sand dunes are formed by aeolian activity, which is the process of sediment being eroded by the wind. Because dunes can store long records of aeolian activity, they are also useful indicators of past landscape change. My research investigates the timing of aeolian activity in the Coral Pink Sand Dunes, Utah. Deposit ages are compared to paleoclimate records to understand how aeolian activity has been influenced by climate change.

Site Description



The Coral Pink Sand Dunes are located in southern Utah on the Colorado Plateau. This study focuses on the relict sediment aprons at the base of the Sevier Normal Fault scarp, seen in this photo.

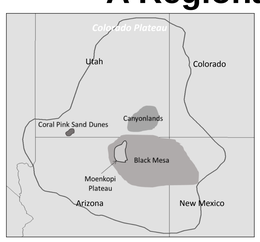
Conceptual Model of Sediment Apron Formation



Sediment aprons formed along Sevier Normal Fault scarp

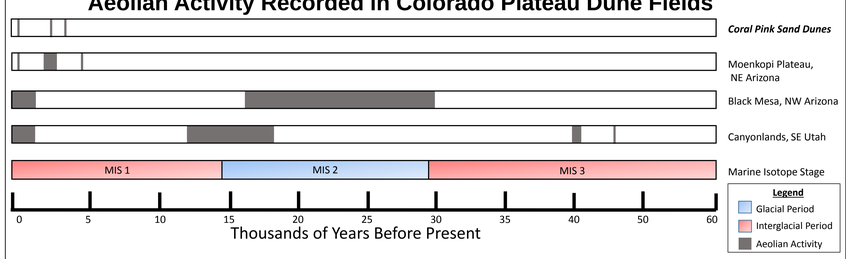
Vegetation and stream incision indicate that these features are now relict

A Regional Record of Dune Activity



- Previous work in the active region of the CPSD field shows late-Holocene aeolian activity corresponds to periods of regional aridity (Wilkins et al., 2007)
- Dune studies across the Colorado Plateau record dune activity as far back 46 Ka (Reheis et al., 2005)
- Topographic controls preferentially preserve older periods of dune activity (Ellwein et al., 2015)

Aeolian Activity Recorded in Colorado Plateau Dune Fields



Research Questions

1. Do the structurally-controlled sediment aprons preserve a longer record of aeolian deposition than the main dune field?
2. When have these dunes been active in the past?
3. What were the climate conditions during past periods of dune activity?

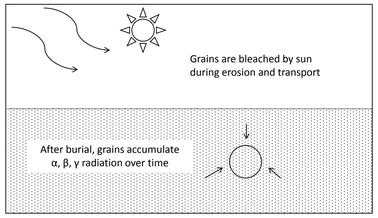
Methods

Field Methods
- Stratigraphic mapping
- Identify aeolian units
- Sample collection

Laboratory Methods
- Optically stimulated luminescence (OSL) dating
- Grain size analysis

Analysis
- Compare timing of aeolian activity to paleoclimate records and nearby geomorphic records

How does OSL work?

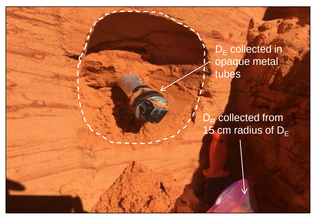


$$Age\ (Ka) = \frac{D_E(Gy)}{D_R\left(\frac{Gy}{Ka}\right)}$$

D_E Equivalent dose rate is the amount of laboratory radiation needed to induce a luminescent signal equal to the natural luminescent signal of the sample.

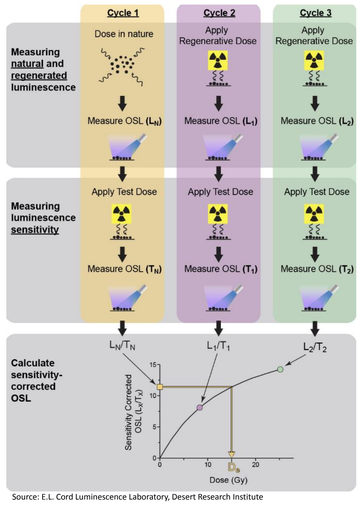
D_R Dose rate is the dose per unit time received by the sample while it was buried, and is calculated from the elemental radioisotopes in surrounding sediment.

Sample Collection



1. Describe stratigraphy
2. Identify aeolian deposits
3. Collect D_E and D_R samples for OSL analysis

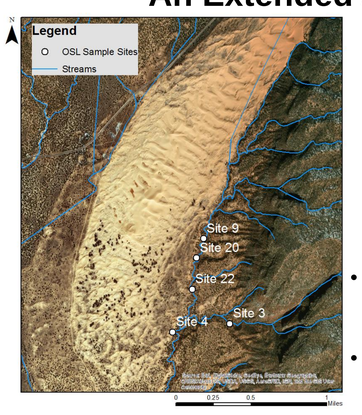
Laboratory Analysis



Source: E.L. Cord Luminescence Laboratory, Desert Research Institute

Results

An Extended Aeolian Chronology

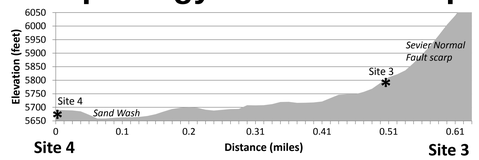


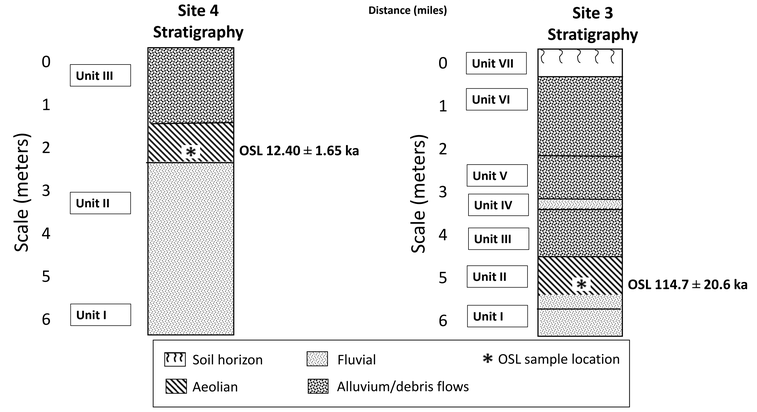
Site ID	Elevation (feet)	OSL age ka (2SE)
Site 4	5671	12.40 ± 1.65
Site 3	5801	114.7 ± 20.6
Site 9	5758	142.7 ± 20.4
Site 20	5747	123.0 ± 18.6
Site 22	5720	149.8 ± 20.0

- Sediment aprons preserve periods of aeolian activity at 12 ka, ~110-120 ka (MIS 5d-5e), and ~140-150 ka (mid-late MIS 6)
- These results extend the record of aeolian activity on the Colorado Plateau by 100 ka

Discussion of Results

Geomorphology of Sediment Aprons

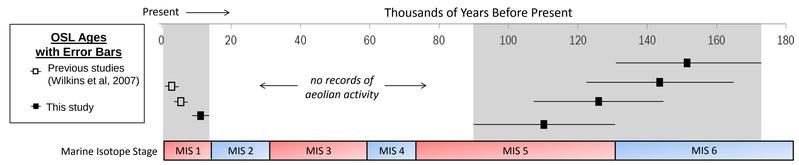




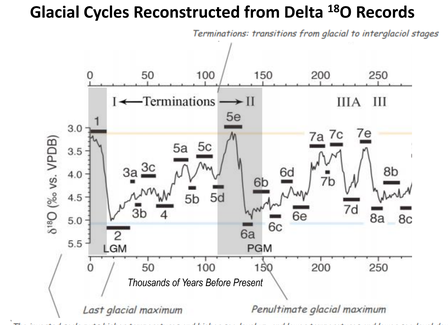
What can these sand dunes tell us about past landscape change?

- Timing of activity is being compared to global and regional paleoclimate records and nearby geomorphic records
- Timing of aeolian activity is clustered around times when Earth's climate has transitioned from colder, glacial climates to warmer, interglacial climates
- This study provides the first evidence of aeolian activity during the last major glacial period on the Colorado Plateau (MIS 6)

Chronology of Coral Pink Sand Dune Activity



Glacial Cycles Reconstructed from Delta ^{18}O Records



Source: Railsback *Some Fundamentals of Mineralogy and Geochemistry*

Conclusions and Future Work

- Landscape change corresponds to major climate change events
- This record shows that the landscape changes observed today are not unprecedented
- Recognizing these patterns can help us to plan for the increasing vulnerability of our landscapes and ecosystems in a warming world

References

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E.L. Cord Luminescence Laboratory, Desert Research Institute https://www.dri.edu/luminescence-lab

University of Georgia <http://www.gly.uga.edu/railsback/Fundamentals/SFMGSubstages01.pdf>

Reheis, M.C., Reynolds, R.L., Goldstein, H., Roberts, H.M., Yount, J.C., Axford, Y., Cummings, L.S. and Shearin, N., 2005. Late Quaternary eolian and alluvial response to paleoclimate, Canyonlands, southeastern Utah. Geological Society of America Bulletin, 117(7-8), pp.1051-1069.

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