5-2016

11th New World Luminescence Dating Workshop
Scientific Program and Abstracts and Field Trip Guide Book

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11th New World Luminescence dating workshop

May 19-21, 2016 Lincoln, Nebraska

SCIENTIFIC PROGRAM and ABSTRACTS

Sponsored by: UNL Luminescence Geochronology Lab and USGS Luminescence Lab

UNIVERSITY OF Nebraska Lincoln

USGS science for a changing world
11th New World Luminescence dating workshop
May 19-21, 2016
University of Nebraska-Lincoln

Organized by:
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Sponsored by:
Conservation and Survey Division and School of Natural Resources,
University of Nebraska-Lincoln
United States Geological Survey

Location
Hilton Garden Inn Downtown Haymarket
801 R. Street
Lincoln, NE 68508
402-475-9000

Emergency Contact:
Paul Hanson 402-853-6540

Thanks to Jacki Loomis (UNL), Karen Gilbert (UNL), Lisa Greif (UNL), Rebecca Young (UNL), and Harrison Gray (USGS) for their assistance in hosting this meeting.
Thursday, 19th May

8:00 – 9:00am  On-site registration
9:00 – 9:10am  Welcoming remarks and information

Session 1: Method developments

9:10-9:30 am  Michael J. Lawson and Edward J. Rhodes  
Sinusoidally Modulated - Optically Stimulated Luminescence (SM-OSL): a more rapid Linearly Modulated- OSL (LMOSL) and the quest for the medium component.

9:30-9:50 am  Nathan Brown, Edward J. Rhodes and Mark Harrison  
Thermoluminescence signals from bedrock K-feldspars: Minimum cooling ages from a glacial valley

9:50-10:10 am  Harrison Gray, Shannon Mahan and Gregory Tucker  
Connections between geomorphic process and the partial bleaching of luminescence

10:10 -10:50 am  COFFEE BREAK

10:50-11:20 am  Invited Keynote Speech  
André O. Sawakuchi, Thays D. Mineli, Luciana Nogueira, Vinícias R. Mendes and Andre Zular  
Quartz luminescence sensitivity: natural controls and application as sediment tracer and paleoclimate proxy

11:20-11:40 am  Shannon Mahan  
Thermoluminescence of soil as a means to estimate the temperature of wildfires

11:50-1:30 pm  LUNCH

Session 2: New applications of luminescence dating I

1:30-1:50 pm  Jacob C. Bruihler and Paul R. Hanson  
Dating Late Quaternary Alluvial Fills in the Platte river Valley using Optically Stimulated Luminescence Dating

1:50-2:10 pm  Kirk F. Townsend, Michelle S. Nelson, Tammy M. Rittenour and Joel L. Pederson  
A reconstruction of Holocene arroyo dynamics in Kanab Creek, southern Utah, using single-grain OSL dating.
Michelle Nelson, Tammy Rittenour, Helen Malenda and Frank Pazzaglia
Luminescence properties and mineralogical composition of sediments from South Anna River terraces in the Central Virginia Seismic Zone

2:30-4:30 POSTER SESSION

Abdulaziz G. Alghamdi, Joel Q.G. Spencer and DeAnn Presley
Dating of Attic Dust at an Abandoned Mine in Central USA

Catherine Buckland, David Thomas and Richard Bailey
Determining landscape sensitivity to natural and human disturbances using Optically Stimulated Luminescence techniques, Nebraska Sandhills

William Johnson, Alan F. Halfen and Tammy Rittenour
Continued Investigations into the Pre-History of the Arkansas River System of Western Kansas

Zachary Olson and Paul Hanson
Formation of Sand Ridges in the eastern Platte River valley, Nebraska

Luminescence chronology of Terra Firme development in western Amazonia lowlands

David Sammeth
A Proposed Study: Synthetically Grown Quartz as a Model System to Characterize Luminescence Properties Observed in Natural Quartz samples

André Zular, André O. Sawakuchi, Hong Wang, Carlos C.F. Guedes and Paulo C.F. Giannini
OSL age assessment in a low dose rate environment: the Lençóis Maranhenses eolian dunefield case

6:00-8:00 Banquet at Hilton Garden Inn
Friday, 20th May

9:00 – 9:20 am  Shannon Mahan: *Topics of interest for the luminescence dating community*

Session 3: New applications of luminescence dating II

9:20-9:40 am  **Sebastien Huot and Henry Loope**
*Radium 226 excess and optically stimulated luminescence dating (OSL): tell me your age, please!*

9:40-10:00 am  **Tammy Rittenour, Daniel Ellerton and James Shulmeister**
*OSL dating sand dunes and mega-podzols, Rainbow Beach Australia*

10:00-10:20 am  **William Johnson and Paul R. Hanson**
*Using OSL Dating to Develop a Landscape Model for Eglin AFB, Northwest Florida*

10:20 – 10:40 am  COFFEE BREAK

Session 4: New applications of luminescence dating III

10:40-11:00 pm  **Sachiko Sakai, Hector Neff and William Krill**
*Optically Stimulated Luminescence (OSL) dating of Little Springs Lava Flow: Impact of Lava Flows to Human Adaptation in Mt. Trumbull, Arizona*

11:00-11:20 pm  **Carlie J. Ideker, Tammy M. Rittenour, Judson B. Finley and Michelle S. Nelson**
*Single-Grain OSL Dating Intermountain Ware Ceramics from Four Archaeological Sites in Northwestern Wyoming*

11:20-11:40 pm  **James K. Feathers and Astolfo G.M. Araujo**
*Luminescence Dating of Paleoindian sites in the Rio Claro drainage, Brazil.*

11:40-1:30 pm  LUNCH

1:30  FIELD TRIP departs from Hilton Garden Inn, return to Lincoln Saturday evening


**Dating of Attic Dust at an Abandoned Mine in Central USA**

Abdulaziz G. Alghamdi¹, Joel Q.G. Spencer², DeAnn Presley¹

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The study of attic dust thought to be associated with past mining activities is of interest given the potential impact to human health. Currently no information exists to constrain the timing of attic dust accumulation compared to activities at nearby mines in the central part of the United States. One such mine is the lead and zinc mine located in Galena, KS, which is part of the Tri-State Mining District of southeast Kansas, southwest Missouri, and northeast Oklahoma. Mining started in Galena in 1871 and the mines were closed in the 1970s. The abandoned Pb and Zn mines have left a legacy of environmental contamination. Attic dust is defined as the dust that settles in households where the influence of humans is limited. The main goal of this study is to characterize attic dust in up to 8 buildings in Galena, KS. One of the main objectives is to use optically stimulated luminescence (OSL) techniques to date the minerals that are present in the dust, to determine the timing of deposition. Dating the attic dust will tell us when the dust was originally deposited in households in Galena, KS, and how this correlates with the history of mining activities. Attics have been selected where there is little or no human activity and conditions are dark on a daily basis. The attics were sampled using safelights and two different sampling methods: first, by sweeping the dust with a brush; and, second, by vacuuming the dust. Preliminary investigations on 90-125 μm quartz demonstrate sufficient natural OSL with 3-mm multi-grain aliquots, robust dose-recovery test results, and a $D_e$ value of about 0.11 Gy.
Dating Late Quaternary Alluvial Fills in the Platte River Valley

using Optically Stimulated Luminescence Dating

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Alluvial fills underlying the Platte River Valley in Nebraska record the geologic history of the Platte River in the late Quaternary. This study investigated the alluvium underlying the valley near the cities of North Platte and Kearney, Nebraska. Data obtained from sediment cores drilled in the alluvial deposits was used to investigate the changes in Platte River dynamics on a glacial – interglacial timescale. Optically Stimulated Luminescence (OSL) dating was used to determine burial ages of recovered sediments and to quantify the thicknesses of the late Pleistocene and Holocene alluvial fills at each study area. Our geochronology depicts considerable differences in age with depth at the two study sites. Results from OSL dating indicate that the Platte River was aggrading during the late Pleistocene and into the early Holocene. Approximately 8 to 10 meters of sediment was deposited near North Platte, and 15 + meters of sediment was deposited near Kearney. Aggradation ended sometime in the early Holocene, most likely between 10 to 11.9 ka, and during the Holocene the Platte re-worked these older alluvial deposits. The total thickness of the Holocene fill ranged from 3 to 8 meters near North Platte, and 10 to 12 meters near Kearney. Locally, the Holocene alluvial fill is entrenched 3 to 4 meters into the underlying late Pleistocene alluvium. This fundamental change in river dynamics is attributed to long-term changes in the ratio of discharge to sediment supply in the basin.
Determining landscape sensitivity to natural and human disturbances using Optically Stimulated Luminescence techniques, Nebraska Sandhills

Catherine Buckland¹, David Thomas¹, Richard Bailey¹

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Two billion people living in drylands are affected by land degradation (Middleton et al., 2011). Sediment erosion by wind and water removes fertile soil and destabilises landscapes (Mangan et al., 2004). Vegetation disturbance is a key driver of dryland erosion caused by both natural and human forcings: drought, fire, land use (Cook et al., 2009), grazing pressure. A quantified understanding of vegetation cover sensitivities and resultant surface change to forcing factors is needed if the vegetation and landscape response to future climate change and human pressure are to be better predicted. Through the use of luminescence dating, archival sources and modelling techniques, this study determines how the environment has recorded and retained sedimentary evidence of natural and anthropogenic disturbances over the last two hundred years. Focusing on the Nebraska Sandhills, we use generalised linear modelling of secondary disturbance datasets coupled with a high-resolution luminescence-derived record of environmental response to test the relationships between forcing factors and landscape stability.

Sampling strategy has focused on sites of known disturbance with availability to local and regional secondary datasets, and previous evidence of high environmental dose rates (> 2Gy/ka). Individual dunes of known and modern age have been sampled to provide a test case for determining the suitability of the p-IR IRSL versus OSL signal when dating sediments of recent depositional history and identifying known surface change. Sediment samples have been collected at a high-spatial resolution to test for spatial homogeneity in response to environmental disturbances across the landform to landscape scale. This research allows us to: i) identify thresholds and lags in surface stability, ii) suggest the level of change required to leave a signature in the environment and iii) bridge the gap between ecological thresholds and sediment movement.


Thermoluminescence signals from bedrock K-feldspars:

Minimum cooling ages from a glacial valley

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Thermoluminescence signals from bedrock K-feldspars are shown to contain information about geothermal histories. Specifically, the location of the leading edge of natural emissions (i.e., $T_{1/2}$) is related to the modern temperature since a thermal event and the integrated counts for each peak give minimum ages since this event. Isothermal decay experiments and TL signals from thermally-stable drill core samples illustrate the thermal control of the $T_{1/2}$ position. Using the sample-specific relationship between isothermal $T$-$t$ conditions and $T_{1/2}$ position, natural dose response curves can be emulated and the minimum cooling age can be calculated (translating this minimum age into a finite age requires thermokinematic modeling not yet finalized).

The Rock Creek glacial valley, north of Yellowstone National Park shows clear geomorphic evidence of multiple glaciations and post-glacial mass wasting. We use this $T_{1/2}$ protocol to offer insight into the timing of these processes. These ages are then compared with regional geomorphic surface ages including cosmogenic $^{10}$Be surface exposure ages of morainal boulders found 18 km to the southeast (Licciardi & Pierce, 2008) and $^{230}$Th/U ages from pedogenic carbonates within glacio-fluvial terraces of the Wind River Basin, about 200 km to the south (Sharp, et al., 2003).

References:


Luminescence Dating of Paleoindian sites in the Rio Claro drainage, Brazil

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The Rio Claro region of Sao Paulo state in Brazil is important for Paleoindian studies because it is situated at the intersection of three different lithic traditions, all dating as early as Clovis. The University of Sao Paulo has recently been investigating the geology and the archaeology of the region. OSL dates on quartz are reported from the Alice Boer site, an early site with bifacial lithics, and the Lagoa do Camargo site, an early site with unifacial lithics. OSL dates from some geological samples from various terraces are also reported. The samples from the archaeological sites are badly mixed, and discussion will focus on how fluvial deposition, bioturbation and sheet wash can affect equivalent dose distributions.
Connections between geomorphic process and the partial bleaching of luminescence

Harrison Gray\textsuperscript{1,2}, Shannon Mahan\textsuperscript{1} and Gregory Tucker\textsuperscript{2}

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Many researchers have noted or suggested connections between the partial bleaching of luminescence in fine sand (90-250 µm grain size) and the geomorphic processes that transport them. In this presentation, we show results from numerical modeling of geomorphic transport of quartz and feldspar fine sand in rivers and in hillslopes and the expected luminescence for each grain of sand. We explore the distributions, magnitudes, and overdispersion of luminescence measurements using random-walk and continuum approaches and show how they can be quantitatively tied to geomorphic process. For rivers, we show that partial bleaching is sensitive to water turbidity, but also to the velocity of river transport and the time spent in storage centers such as floodplains. Interestingly, it seems to be possible to extract sediment virtual velocities and rates of exchange with floodplain storage centers. This information is valuable for testing hypotheses on the effects of climate change on sediment transport. For hillslopes, we show that the percentage and patterns of sediment bleached in a soil profile can be used to estimate vertical diffusivities in hillslope soils. This method may be helpful in collecting diffusivity data where few other methods are available. Current work to test these results with independently obtained values is ongoing and we show that our preliminary results match model predictions. There exists significant potential to use luminescence as a process-sensitive geomorphic tracer.
A glacial deposit section along a river bend in south-central Indiana was recently ‘rediscovered’. The exposure consists of sorted glaciofluvial sediments (sand, gravel, and fossiliferous silt) sandwiched between two tills. The lower and upper till units were interpreted as associated to the maximum ice extent and an ice reoccupation, respectively, during the Late Wisconsinan. Sedimentological evidence suggest that this glaciofluvial sediment package was deposited during a short time interval. Radiocarbon ages were performed on plant macrofossils and gastropods from the fossiliferous silt. This allows us to constrain the timing for the burial of this deposit, to a window of about 21 – 22 ka.

In an attempt to further constrain the timing of these events, two samples for optically stimulated luminescence (OSL) dating were retrieved from a sandy deposit located in the glaciofluvial unit. Difficulties were encountered during the OSL dating, most notably partial bleaching. Partial bleaching, if not properly taken into account, produces an OSL age overestimation. In addition, it was found that these sediments suffer from uranium disequilibrium (prominent radium 226 excess). This violates a key requirement for OSL dating.

We will explore various hypotheses and attempt to model the time dependence of the dose rate to confirm the burial age of this glaciofluvial package.
Oral Presentation

Single-Grain OSL Dating Intermountain Ware Ceramics from Four Archaeological Sites in Northwestern Wyoming

Carlie J. Ideker¹, Tammy M. Rittenour¹, Judson B. Finley¹, Michelle S. Nelson¹

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Late Period (<1500 years), high-altitude (>2600 m asl) archaeological sites in northwestern Wyoming, USA, prove difficult to date with traditional radiocarbon methods. The presence of Intermountain Ware ceramics at these sites presents an opportunity to use single-grain optically stimulated luminescence (OSL) to date vessel manufacture and site occupation, as the use-life of the vessels (<10 yrs.) is encapsulated within the standard error of the technique. This study presents single-grain ages from quartz temper of Intermountain Ware sherds and investigates potential post-depositional thermal resetting of luminescence signals by wildfires. Ceramic sherds were obtained from four sites in northwestern Wyoming: Boulder Ridge, High Rise Village, Caldwell Creek, and Platt. Each site, except Caldwell Creek, has existing radiocarbon ages that provide independent age control. Additionally, all sites except Platt were impacted by past wildfires of varying intensity and consequently provide a test of the thermal resetting capabilities of wildfires.

Luminescence results demonstrate single-grain OSL dating of quartz temper from Intermountain Ware ceramics can provide improved accuracy and precision over radiocarbon dating when sherds are not adversely affected by wildfires. Boulder Ridge sherds were recovered from the surface of the site after exposure to a high-intensity wildfire and consequently, luminescence signals were reset. High Rise Village and Caldwell Creek also burned in wildfires of varying intensities, however sherds were recovered from excavated contexts and retain intact luminescence signals. These results underscore the need for cultural resource managers to sample from subsurface contexts. These results also validate single-grain OSL dating of ceramic temper as a valuable chronometric tool for cultural resource managers and archaeologists seeking to build and refine existing site and regional chronologies.
Continued investigations into the Pre-History of the Arkansas River System of Western Kansas

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For the past few years, an investigation has been underway into the chronology of dune activation in the Arkansas River valley of southwestern Kansas (A.F. Halfen and others). We are now expanding that work to include the nature and chronology of associated changes in the Arkansas River alluvial environment, using both OSL and AMS $^{14}$C. With the de-watering of the alluvial aquifer through groundwater mining and upstream channel diversions, construction-material quarry operations have excavated sand and gravel from depths of 20 m or more below the modern-day channel bed. This has exposed a stratigraphic sequence including features such as a buried, thick organic mat radiocarbon dating to the Younger Dryas event, and at the greatest depths a pronounced highly-oxidized and calcified paleosol. This paleosol, assumed to be an expression of the Meade Formation, dated to about 75 ka, the oldest alluvium-derived age thus far. The presumed highest terrace, which is mantled by 20 or more meters of dune and sheet sand, produced an OSL age of about 63 ka, with overlying aeolian and colluvial sands exhibiting ages of 15 ka to 0.4 ka. Remnants of a sinuous paleochannel, situated on a terrace below the 63 ka-dated fill, date to the Last Glacial Maximum and are presumed vestiges of an ancestral Arkansas River.
Using OSL Dating to Develop a Landscape Model for Eglin AFB, Northwest Florida

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Eglin Air Force Base, located in northwestern Florida adjacent to the coast, is unique from the landscape perspective in that it encompasses the upland developed on the Citronelle Formation (Neogene), alluvial terraces of the Yellow River on the north, marine terrace system ranging from 2m to 21m amsl (e.g., Pamlico and Silver Bluff), the embayment of the East Bay and Yellow rivers, and the barrier island complex (Santa Rosa Island). Our primary goal is that of developing a landscape-age model for the base, one that can be used to gauge the probability of containing prehistorical cultural remains, especially those of the first occupants within the area (Paleoindian-Early Archaic). OSL ages obtained thus far have focused on presumed Pleistocene shoreline mantled with Holocene aeolian sands, high-level marine terrace, mid-level marine terrace, low-level marine terrace, and dunes on the barrier island. Though preliminary, the OSL ages are the magnitude anticipated from scant AMS and bulk ¹⁴C ages and cultural artifact data obtained during previous research. The Pleistocene shoreline (Rosemary Beach site) exhibited a buried soil, where OSL samples included one above the paleosol in aeolian sands (13.4 ka), within the paleosol (35.4 ka), and a third below the paleosol (23.8 ka), which suggests that the paleosol dates to MIS 3, with latest Pleistocene cover sands. The high-level marine terrace (Fort Rucker North site) produced an age of about 115 ka at 2.2 m bs; the mid-level terrace (Fort Rucker site) ages of 3.5 ka (60 cm bs), 24.7 ka (170 bs), and 103 ka (330 m bs); and the low-level terrace an age of 26 ka (1 m bs). The youngest ages were derived, as anticipated, from the dunes on the barrier island—2.2 ka and 1.8 ka from blowout exposures in the largest accessible dunes. These OSL ages, in conjunction with earlier ¹⁴C ages, LiDAR data, and high-resolution imagery, provide a promising start to development of a temporally-controlled landscape model for Eglin AFB.
Sinusoidally Modulated - Optically Stimulated Luminescence (SM-OSL): a more rapid Linearly Modulated- OSL (LM-OSL) and the quest for the medium component.

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In traditional Linearly Modulated- OSL (LM-OSL), the intensity of the light source is increased linearly, ramping up stimulation so that the various components within the quartz signal can be observed. Due to long measurement times, LM-OSL is rarely used despite its versatility in analyzing the fast, medium, and numerous slow components. We present a modified version of LM-OSL, in which the stimulation intensity is not ramped linearly, but instead follows a sinusoidal function. Sinusoidally Modulated- Optically Stimulated Luminescence (SM-OSL) offers the same potential for component analysis as LM-OSL, but far more rapidly. The initial stimulation is very low and is equivalent to a multi hour LM-OSL. As the stimulation time increases, the intensity grows following a sine function which ramps up more quickly than traditional LM-OSL. SM-OSL allows for the rapid assessment of quartz OSL components, with increased resolution of the fast and medium components.
Oral Presentation

Using Thermoluminescence to Remotely Monitor Wildfire Soil Temperatures

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The Silverado wildfire occurred from September 12 to 20, 2014, burning 960 acres in Orange County, California. We used several locations within the burn area as natural experiments to test the efficacy of using thermoluminescence (TL) to discern wildfire heating temperatures at different soil depths. The hypothesis that we pursued was that when a large wildfire burns a landscape, grains near the top of a soil profile would be heated and bleached and deeper grains would be unscathed. In particular, the slowly bleaching TL peak (SBP; 375 °C) is reduced by light, but not eliminated (i.e. there is a residual). Grains exposed to just light should still have an SBP, whereas grains exposed to high heat (>500 °C) won't (McKeever 1991). In theory, this means that as TL is measured in the collected sediment core an increased signal with depth should result due to surface heating (or light exposure). There should also be some variation of the strength of the signal peaks at 100 °C, 150 °C, 200 °C, 250 °C, 300 °C, 350 °C, 400 °C, and 500 °C (Duttine et al, 2005).

Initial soil cores were obtained from the site in November 2014 in order to determine if the material was suitable for luminescence measurements, and the results showed the material was sourced from meta-sedimentary bedrock, contained quartz and feldspar in adequate quantities, and that these minerals contained both TL and OSL in measurable quantities. On April 23, 2015 10 cores were obtained throughout the burned watershed, and 2 cores were taken in unburned areas as a control. The sample cores were slotted into 2-cm metal partitions up to a maximum depth of 14 cm in order to allow laboratory subsampling of the core in depth increments.

Previous research on wildfires indicates that there is limited heat transferred below ~9.5-cm depth in soils (to a maximum depth of 30 cm) due to the insulating factor of sediment (Preisler et al 2000). These same studies observed that during prescribed fire burns the heat of the fire varied according to the fuel; for example, sediment beneath trees and shrubs burn hotter than grasses (Monsanto and Agee, 2008). We prepared the silt from 2 cores and simply glowed out the TL in each 1-cm segment to see the results. Additionally, we pre-heated several discs from each of the core subsamples at temperatures in a muffle furnace from 100 to 500 °C in order to see how the TL curves would change when heated to certain, controllable temperatures. We then compared these curves with a natural sample from each 1-cm section. Our preliminary data suggest that sediment from the first 6 cm is very similar to the TL curve obtained from the samples at that depth heated to 150 °C. Deeper
sediment shows a relatively low TL count, suggesting that it was not heated. One anomalous result from this preliminary dataset is that most samples that were heated between 100 and 350 °C tended to show decreased TL count peaks; however, above 350 °C many TL peaks began to show increased growth.

Figure 1. An example of the TL curves (natural to 500 °C preheat) from the top of the sediment of Core 10.
Oral Presentation

Luminescence properties and mineralogical composition of sediments from South Anna River terraces in the Central Virginia Seismic Zone

Michelle Nelson¹, Tammy Rittenour¹,², Helen Malenda³, Frank Pazzaglia⁴
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The South Anna River is a large (~1,036 km²) tributary to the Chesapeake Bay and crosses the Central Virginia Seismic Zone (CVSZ). The CVSZ is characterized by a number of mapped faults, and recent and historical seismic activity has been identified in the area, including the August 23, 2011 5.8 magnitude earthquake near Mineral, VA. The river crosses a complicated tectonic structure of Proterozoic to Paleozoic metamorphic and igneous lithologies in the VA Piedmont which includes a belt of economic mineral resources such as gold, iron, copper, lead, and zinc sulfide deposits. Secondary vein quartz is prevalent in the region along with quartzite. Weathered alluvium, residuum, and bedrock regolith from river terraces have been dated using optically stimulated luminescence (OSL) and infrared stimulated luminescence (IRSL) dating (Malenda, 2015).

Luminescence properties are described for both quartz and feldspar mineral extracts from each sample due to the heterogeneous, weathered and less-than-ideal nature of the sampled deposits. Most samples were dated using IRSL on feldspar, as quartz signals show high sensitivity yet low-saturation levels on regenerative doses (50-100 Gy). In contrast, one set of samples from an active Vermiculite mine sourced from a quartz diorite and hornblendite plutonic rock was dated with quartz OSL as IRSL signals were relatively dim and regenerative doses on quartz signals were below saturation (Figure 1).

This paper explores the purity, quality, and chemistry of the quartz and feldspar minerals present in the processed luminescence samples through scanning electron microscopy (SEM) imaging, energy dispersive X-ray spectrometry (EDS), and X-ray diffraction (XRD). Coupled with these mineralogical analyses, we will explore linear-modulated OSL (LM-OSL) to describe components contributing to luminescence signals in both quartz and feldspar. Finally, we compare traditional OSL ages with results from thermal transfer OSL.
Figure 1: USU-1580 ‘Quartz’ sample from active Vermiculite mine site. A) SEM image of grains shown in B. B) EDS layered image of processed sample (for quartz OSL dating); grains contain elements Al, Mg, and F (biotite) in addition to Si and O (quartz). C) OSL shine-down for 1-mm small-aliquot, inset is Lx/Tx dose response curve. Sample shows rapid decay to background in first second of blue LED stimulation indicating signal is dominated by the fast component.

Formation of Sand Ridges in the eastern Platte River valley, Nebraska

Zachary T. Olson\(^1\) and Paul R. Hanson\(^1\)

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Sand ridges on the floodplain in the eastern Platte River valley are elongate features that range from approximately 150-1600 meters in length and 20-40 meters in width. They are fairly dramatic features as they lie approximately 3-4 meters above the low relief landscape of the surrounding floodplain. The ridges are preferentially found on the southern and eastern banks of abandoned channels of the Platte River. Historically, there has been abundant research that focused on the active Platte River channel bed, its sediment load, and the morphology of the river’s sand bars, however no studies have addressed the formation of these ridges which is the objective of this investigation. Thirteen cores were collected for the project, seven near the town of Silver Creek, and three from Two Rivers State Recreational Area. The ridges were cored using three inch aluminum pipes that are vibrated into the ground by way of a backpack-mounted vibracore apparatus. Cores penetrated to depths of up to 3.8 meters. Particle size analysis was conducted using laser diffraction on samples taken at 10 cm intervals in each core. The ridge fills are predominantly very fine to medium sand with zones of coarse sand. The upper portions of each sand ridge core showed no apparent bedding, but prominent lamination is present in all cores below a meter of the soil surface. OSL dating was used to determine the time of deposition for individual sediment packages within the cores and estimate the depositional ages for all of the sampled sand ridges and adjacent alluvial plain. Nine Preliminary OSL ages suggest the ridges sampled were deposited approximately 500-1,500 years ago. Ongoing investigations are being conducted to investigate whether the sand ridges were deposited by eolian or alluvial processes.
Luminescence chronology of Terra Firme development in western Amazonia lowlands

Pupim, F.N.¹, Sawakuchi, A.O.¹, Cruz, F.W.¹, Almeida, R.P.¹, Lohmann, L.G.², Nogueira, L.¹, Mineli, T.D.¹, Marconato, A.¹, Grohmann, C.H.³

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The modern Amazonia landscape and biodiversity are strongly associated with the evolution of the Amazon River system. Paleogeographical models suggest that the shift from a large wetland dominated by avulsive channels and flooded forests to the incised transcontinental river valley (Várzea) is the geological event that has had the greatest impact for the diversification of the Amazonian Biota. Nonetheless, there is no consensus about the time of formation of the Terra Firme and shifts from wetland flooded forests to non-flooded forests in western Amazon lowlands. This landscape shift is thought to have occurred between the Miocene (11 Ma) and the Late Pleistocene (100 ka). This large time interval may be due to a lack of absolute ages for the sediments forming Terra Firme forest substrates in western Amazonian lowlands. In Brazil, the Içá Formation represents the uppermost fluvial deposits representing Terra Firme forests substrates in western Amazonia. Therefore, a reliable chronology for the last depositional stage of the Içá Formation is key for an improved understanding of the formation of the Terra Firme-Várzea system. Three sediment profiles from Içá Formation were sampled along the margins of the Solimões and Içá rivers for Optically Stimulated Luminescence (OSL) dating of quartz, using a Single Aliquot Regeneration (SAR) protocol. The dose recovery test using a preheat temperature of 200°C resulted in a calculated-to-given dose ratio of 0.96 ± 0.05 for a given dose of 100 Gy. The calculated equivalent doses ranged from 50 to 130 Gy (Central Age Model), with moderate (25%) to high (57%) over-dispersion values. Dose rate values ranged from 0.4 to 2.0 Gy/ka. The resulted burial ages for these three profiles were from 50 to 155 ka (ages by location and from top to bottom: Coari 63.5±6.1, 55.4±5.5, 70.5±7.2 ka; Tefé 155.5±14.4, 86.4±12.0, 121.8±11.3, 98.1±9.8, 100.5±15.7, 99.4±9.1 ka; Santo Antônio do Içá 50.5±5.6, 58.9±5.9, 134.5±11.9, 117.9±13.0 ka). Age inversions appear to be associated to dose rate changes through time. Equivalent dose data are robust, showing values below saturation and most samples with over-dispersion compatible with well-bleached sediments. Water content variation and mobility of radionuclides due to weathering are possible sources of dose rate changes through time. Despite the age uncertainties, we generated the first robust geochronological dataset that indicates Late Pleistocene ages for the last stage of built up of the Terra Firme in the western Amazonian lowlands. Future efforts will be concentrated in dose rate modeling in order to enhance age accuracy. (FAPESP grants 2012/50260-6 and 2014/23334-4)
OSL dating sand dunes and mega-podzols, Rainbow Beach Australia

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The Sunshine Coast of southeast Queensland, Australia is home to an extensive system of Pleistocene age coastal dune fields and barriers islands that contain an archive of sea level and climate change in the Australian sub-tropics. Fraser Island, the largest sand island in the world and the adjacent Cooloola Dune Field, form the northern part of these extensive sand barriers and are currently protected as part of Great Sandy National Park, a World Heritage listed site. Previous work has focused on the modern hydrology and biology of the region, little work has involved the investigation of the timing of formation and evolution of these dune and barrier systems.

Samples for optically stimulated luminescence (OSL) dating were collected by the co-authors to investigate the ages of the dune sand exposed along Rainbow Beach, a part of the Cooloola Dune Field in southeast Queensland. Rainbow Beach was so named due to the brightly colored mega-podzol humid subtropical soil horizons exposed along the 100+ m tall coastal bluffs. These soils have thick elluvial and leached white E-horizons that are > 5 m in places and similarly thick (up to 10m) underlying bright red to brown B horizons. Less weathered C horizons are tan colored for the youngest dune sands to yellow-orange for the older deposits.

Dose rate calculations based on K\%, U and Th ppm are highly dependent on the soil unit sampled. In general the less weathered C horizons of the younger sand units have the highest radio-elemental concentrations with 0.16 ±0.02 %K, 1.8 ±0.7 ppm Th and 0.4±0.1 ppm U. The E horizons of the soils and C horizons of the older units have lower radio-elemental concentrations of 0.03 ±0.03 %K, 0.9 ±0.3 ppm Th and 0.2±0.1 ppm U. B horizons were not sampled for OSL dating, but are expected to have higher radio-elemental concentrations as they would have accumulated the elements that were leached from the E horizons.
This paper discusses the influence of mega-podzol soil leaching on the ability to obtain accurate OSL age estimates from the stacked dune and soil sequences at Rainbow beach. Estimates of dose rate and ages in relationship to modeled elemental losses and additions are presented.

Figure 1. (left) Radio-elemental concentrations of sediments from different soil horizons at Rainbow Beach, southeastern Queensland, Australia. (right) Image of Rainbow Beach with well developed B horizon in a mega-podzol in foreground.
Optically Stimulated Luminescence (OSL) dating of Little Springs Lava Flow: Impact of Lava Flows to Human Adaptation in Mt. Trumbull, Arizona

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This paper employs OSL to date the Little Springs lava flow, near Mt. Trumbull, northern Arizona, thought to have erupted about 1000 years ago. The accepted dates are based on cosmogenic helium dating (Fenton et. al 2001). This lava flow covers some of the most productive agricultural land in the Mt. Trumbull area. Previous archaeological surveys revealed multiple structures and trails built on the top of this lava flow and potentially suggested that their construction was for defensive purposes. In this paper, we re-evaluate the timing of the eruption of the Little Springs lava flow using OSL dating of sediments from just beneath the lava. One goal of this study is to compare OSL dating of the sediment to cosmogenic helium dating for determining the age of lava flows. Second, understanding the timing of the eruption or eruptions will contribute to better understanding of their impact on the Ancestral Puebloan people who inhabited this marginal agricultural environment.

The sediment sample just beneath the lava was collected to determine when the sediment was exposed to the light last time and heated by the lava. Twelve OSL samples were analyzed at luminescence dating lab in IIRMES, at CSULB. Using the lab’s Risø TL/OSL Reader with blue-light (BOSL) and infrared (IROSL) stimulation and a procedure that consists of a coarse-grained, quartz single-aliquot (90-125 μ) regeneration sequence (SAR) protocol, we analyzed each sample and calculated ages. Dosimeric information was taken using LA-ICP-MS for thorium and uranium and p-XRF for potassium.

In our analysis, OSL dates of all samples shows much older dates than 1000 year old. There are a few reasons why OSL dates of the sediment under the lava flow do not agree with cosmogenic helium dating results of the eruption of Little Springs lava flow around 1000 years old. First it is possible the dates based on cosmogenic helium dating may not target the eruption time. However, considering the discovery of several sherds embedded in the lava found near this lava flow, this idea may not be accepted. This is because these sherds are considered to be produced sometimes around AD1000 typologically. The second possibility is that OSL dates of the sediment do not target eruption event. However, the dates especially from multiple locations in southern lobe suggest that dates are generally agreed around 2000-4000 BC. Thus, the OSL dates of the sediment under the lava is not erroneous but suggest the one of eruption events. The third possibility is that the Little Spring lava flow was erupted...
for multiple times, including one around 4000 BC. The last possibility is that lava in southern lobe with
dates between 2000-4000 BC erupted before the one in northern lobe near the site with sherds
embedded in lava, although generally it is agreed that both lava probably erupted at the same time.

Although additional investigation is needed, one information that this study suggests is that
Little Springs lava erupted before prehistoric population utilized the area for agriculture around 4000
BC. Additional eruption or later eruption of northern lobe may impact prehistoric farmer’s life for
certain degree. However, the eruption of Little Springs lava flow may not bring tragic negative impact
on agricultural productivity and human life as it was thought previously.

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Poreda, 2001 Displacement Rates on the Toroweap and Hurricane Faults: Implications for
A Proposed Study: Synthetically Grown Quartz as a Model System to Characterize Luminescence Properties Observed in Natural Quartz samples

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Luminescence dating is possible because the material of interest, usually quartz or feldspar, contains point defects within its lattice structure. These defects (or traps) are either intrinsic (related to Si or O vacancies) or extrinsic in that the defects are related to impurities (foreign elements such as Al or Ti) and the concentration of each is dependent on the conditions of mineral formation or subsequent alteration (Preusser et al., 2009; Roberts, 2008; Weil, 1971; Woda & Wagner, 2007).

The most common impurity in quartz is Al³⁺ since this ion can substitute for Si⁴⁺ ions with the assistance of monovalent ions such as Li⁺ or Na⁺. The resulting (AlO4/M⁺)⁰ species can then trap holes in the form of (AlO4/M⁺)⁺ (Lee et al., 2012; Pnąnov, 1994). Titanium and germanium are also able to substitute for silicon, thereby leading to the creation of electron traps. A variety of clever experimental approaches has been employed to identify other possible electron/hole traps, but without detailed knowledge of the particular chemistry and structure of the system under study it is difficult to correlate cause and effect. As an excellent summary notes, “Reviewing the present knowledge reveals that insufficient information is available to either unambiguously link distinctive lattice defects with characteristic luminescence components, or even to explain problems observed in application studies by potential dynamics of the defects within the crystal” (Preusser et al., 2009).

Currently, two models have been proposed to explain the luminescence phenomenon: one a simple band gap description the other based upon the theory of recombination of ions in the lattice (Aitken, 1985; Botter-Jensen, et al, 2003; Itoh, et al, 2002; Itoh, 1982). Both models have strengths and weaknesses. The defect pair model does a better job of describing observed TL and OSL luminescence, but requires the assumption that all processes are first order kinetics which luminescence data does not support (Aitken, 1985; Botter-Jensen et al., 2003; Pagonis et al., 2010; Yukihara & McKeever, 2011).

The next logical step to improve TL/OSL dating is to characterize the physical and chemical nature of the various traps responsible for luminescence. This will be approached by the development of suitable synthetic models for natural quartz to correlate structural similarities between natural and synthetic samples of quartz grains. The utility of this approach has been demonstrated in luminescent synthetic quartz crystals commercially grown with an Al content = 10 ppm (Martini, Fasoli, & Galli, 2009). The results suggested that the 110 and 325 °C TL is due to the same recombination center as OSL;
that is electron + [AlO4]° → broad 380 nm emission. A major challenge to studying field samples is that the nature and concentration of the impurities are not known. A synthetically prepared sample will contain impurities of known concentration and type.

The intended outcome of these experiments is to produce a synthetic model of quartz that behaves in a manner similar to natural quartz. A solution growth technique called hydrothermal growth will be used to produce quartz crystals containing known quantities of impurities (Laudise, 1987). This technique is very similar to the processes by which natural quartz crystals are formed. The goal is to determine what concentration of particular impurities is required to mimic the dose response curves observed for natural quartz. A synthetic model will provide data that will assist in identify the source and nature of point defects, as well as a method of comparing the defect pair and energy band models proposed to explain OSL.
Quartz luminescence sensitivity: natural controls and application as sediment tracer and paleoclimate proxy

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Quaternary sediments in Brazil are rich in quartz due to heavy tropical weathering and low denudation rate in major sediment source areas. These sediments have quartz grains with relatively high Optically Stimulated Luminescence (OSL) and Thermoluminescence (TL) sensitivities, despite the luminescence sensitivity of quartz grains from different areas can vary in several orders of magnitude. Thus, OSL and TL measurements can discriminate quartz grains from different geological contexts, allowing their use as a proxy useful to solve provenance, stratigraphy and paleoclimate problems. Previous studies propose that the increase of luminescence sensitivity of quartz grains from sediments relates to cycles of irradiation during burial and bleaching by sun light exposure during sediment transport. Thus, quartz luminescence sensitivity would increase along sediment transport pathways (Pietsch et al. 2008). In the Amazon River basin, which is the largest fluvial system in the world, quartz luminescence sensitivity (fast OSL component and TL110°C peak) is more correlated with sediment source areas than with distance of sediment transport. Quartz grains with higher sensitivity come from areas with lower denudation rates as indicated by cosmogenic nuclides (¹⁰Be) data (Wittmann et al. 2011). This suggests that the luminescence sensitivity would increase mainly as result of the surface exposure time of quartz in its source area rather than due to irradiation-bleaching cycles during sediment transport. Confocal microscopy studies show that high sensitivity quartz have higher amount of physical defects compared to low sensitivity quartz. We hypothesize that luminescence sensitivity of quartz grains increases due to their exposure to cosmic radiation, which would produce crystal defects and/or raise the luminescence efficiency through changes in inherited electron/hole traps. Despite the natural controls over luminescence sensitivity of quartz are not fully understood, the luminescence discrimination of quartz from different sediment sources allow several applications in the study of sedimentary systems. We will present the following applications of quartz luminescence sensitivity: 1. Reconstruction of late Pleistocene precipitation changes through the input of fluvial sediments into deep marine settings; 2. Tracking Holocene storminess changes in coastal areas through sediment provenance; 3. Stratigraphic differentiation between Cretaceous sandstone units with similar mineralogical and lithological composition.

A reconstruction of Holocene arroyo dynamics in Kanab Creek, southern Utah, using single-grain OSL dating

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Many alluvial valleys in the American Southwest contain entrenched channels with steep channel banks, called arroyos. Stratigraphic evidence exposed in modern arroyo walls indicates that these fluvial systems experienced repeated periods of entrenchment and re-aggradation during the mid- to late-Holocene. Previous research suggests arroyo dynamics were regionally synchronous, implying that climate fluctuations are the dominant drivers. However, many of these interpretations rely on records with limited and problematic age control, as well as broad correlations across the southwest. While hydroclimatic fluctuations must play a role, intrinsic reach- or catchment-specific geomorphic thresholds to entrenchment are hypothesized to partially control the timing of arroyo processes, suggesting that episodes of arroyo cutting and filling need not necessarily be regionally contemporaneous.

This study focuses on Kanab Creek, southern Utah. Kanab Creek is entrenched within two arroyo reaches that are separated by a bedrock knickzone, indicating that upstream arroyo headscarp migration cannot propagate from the lower reach into the upper reach. This suggests that each reach may have different alluvial histories. Episodes of prehistoric arroyo cutting and filling are reconstructed from 29 sites by recognition of buttressing unconformable contacts in the arroyo-wall stratigraphy and age control derived from single-grain optically stimulated luminescence (OSL) and accelerator mass spectrometry (AMS) radiocarbon dating. Results indicate at least five periods of aggradation occurred since ~6.0 ka in the lower basin, each interrupted by an episode of arroyo entrenchment. Although the upper basin record is not yet well-constrained, stratigraphic and available geochronologic evidence suggests that the earliest period of entrenchment in this reach occurred within dating resolution of the lower reach downstream, suggesting a common response to climate forcing. Comparison of these records to recently completed chronologies from arroyo systems in adjacent catchments indicates near-synchronous arroyo processes over the last ~1.5 ka; however, beyond 1.5 ka correlations are less clear. Broadly contemporaneous alluviation suggests a climatic driver, and comparison to paleoclimate records suggests that arroyo entrenchment events may be driven by transitions from periods of multi-year
drought to wetter periods. However, not all such transitions are associated with arroyo entrenchment, suggesting the importance of geomorphic thresholds in modulating the timing of climate-driven arroyo processes.

Figure 1: Stratigraphic panel of Site KNB-2, an arroyo-wall exposure of five alluvial packages (Qf1, Qf2, Qf3, Qf4, Qf5) separated by paleosols and buttressing unconformable contacts.
Poster Presentation

**OSL age assessment in a low dose rate environment: the Lençóis Maranhenses eolian dunefield case**

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Radiation dose rate measurements from U-Th-K radionuclides using gamma spectrometry in fourteen sand samples from a 13.8-m dune succession in Lençóis Maranhenses, NE Brazil, are in the low range of 0.11-0.49 Gy/ka. This dating context allows us to use quartz OSL dating on about a 100,000-year timescale. The OSL ages (target ages) showed a time span of about 120,000 years ranging from 133.2 ± 6.7 ka to 13.2 ± 0.6 ka. Sands are composed of 95-98 % quartz and lack carbonates and feldspar. The K radionuclide content is on average 0.03 % (min = 0.01 %, max = 0.05 %), making the U and Th radionuclides the major contributors to the dose rate from the sediments. The heavy minerals suite is dominated by zircon and rutile that are the major source of U and Th radionuclides that can be tracked using Zr and Ti concentrations. XRF results of Zr and Ti concentrations taken at every 5 cm show variations over an order of magnitude in the section. Therefore, higher concentrations of heavy minerals surrounding quartz grains could affect beta and gamma dose rates and provide overestimated OSL ages, if not assessed properly. Beta dose rate heterogeneity was not a concern in the centimeter scale because 250-300 g of bulk sample material was used for gamma spectrometry measurements. However, an estimate had to be made of the effects of possible gamma dose rate heterogeneities on final ages, despite the sands being mineralogically mature, well-sorted, and having D₄ values overdispersed only by an average of 18 %. To evaluate gamma dose rate heterogeneities, we selected three target samples from the near-top, middle, and near-bottom of the section (Fig. 1) and calculated the average dose rate including measurements of two samples in a 30-cm radius from the target sample. Results showed that estimated ages were well within the uncertainties of the target ages (Fig. 2). This preliminary data suggest that target ages can satisfactorily establish a chronological framework for the section. Furthermore, considering that equivalent doses up to ~150 Gy can be estimated through the quartz OSL signal – and if sands with this dose were found in our study site - we would be able to determine ages in the 200-700 ka range.
Fig. 1. Luminescence characteristics for three samples taken from the near-top, middle and near-bottom of the profile. A, B, and C indicate decay from natural luminescence signal, growth, and dose distribution curves, respectively.
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11th New World Luminescence Dating Workshop
Field Trip Guidebook

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May 20-21, 2016
University of Nebraska-Lincoln
Introduction

This trip will focus on the loess and dune deposits found in west-central Nebraska. Much of the state’s surficial geology is dominated by either loess or dunes (Fig. 1). Peoria loess is the dominant loess deposit that lies at the surface in the central and eastern part of the state. Peoria loess was deposited between ~ 25,000-14,000 years ago (Bettis et al., 2003; Mason et al., 2011), and thins with distance from the Sand Hills (Mason, 2001; Fig. 2). The Peoria overlies older loess units such as the Gilman Canyon Formation and the Loveland Loess (Muhs et al., 1999; Mason et al., 2007). Locally up to 6 meters of Bignell Loess is found overlying the Peoria, particularly in areas adjacent to the Sand Hills. It was deposited in pulses during the Holocene, and is distinguished from the underlying Peoria by its darker color due to the number of buried soils.

Fig. 1. Topographic regions of Nebraska. The yellow areas are sand dunes and sand sheets and much of the stippled patterns in central and eastern Nebraska are underlain by loess. The region labeled ‘Loess’ is underlain by relatively thick (> 8 m) Peoria Loess. Field trip stops are: 1. Judkins Table, 2. Red Ranch Beds, 3. Vinton Blowout, 4. & 5. Bignell Hill and Moran Canyon.

The Nebraska Sand Hills are the largest sand dune region by area in the western hemisphere, covering ~ 50,000 km² (Fig. 3). Although the landscape is currently stabilized by prairie vegetation, both radiocarbon and optically stimulated luminescence dating of dune deposits indicates widespread mobility multiple times in the Holocene, with the latest event dating to 800-1000 years ago (Miao et al., 2007). Other dune activation events in the Holocene include an activation period between 9000-6000 years ago and shorter events centered around 2500 and 4000 years ago. The large dunes in the Sand Hills were active in the late Pleistocene and have yielded ages that cluster around 17,000-15,000 years ago (Mason et al., 2011), but the dunefield was likely active long before that. The dunes were apparently inactive between ~ 14,000 to
around 9000 years ago around the Pleistocene-Holocene transition. The eastern Sand Hills are dominated by relatively low relief linear dunes that are 10-15 m high and oriented NW-SE. Barchanoid ridges over 100 m high with E-W orientations are found in the central and western portions of the dunefield. Lakes and marshes are widespread today in interdune areas, particularly in the west. Relatively small and low relief dunes are common on abandoned alluvial deposits of the streams draining the Sand Hills, including the Platte River.

Fig. 2. Peoria Loess thickness in Nebraska from Mason (2000). Locations for field trip stops Judkins Table (JT), Bignell Hill (BH) and Moran Canyon (MC) are shown.

Fig. 3. Dunefields of the central and southern Great Plains. Nebraska Sand Hills (NSH) are the largest on the Great Plains.
The broad and relatively flat Platte River valley is a prominent feature on the landscape in Nebraska. We will drive through the valley on both days of the trip, largely when we are travelling along Interstate 80. The Platte River’s watershed is approximately 220,000 km² and drains a portion of the Rocky Mountains in Colorado and Wyoming. The discharge regime has been greatly altered by the placement of dams in Colorado, Nebraska and Wyoming. The Platte valley is underlain by at least 16 m of alluvium in stretches of the valley, much of which is sand and gravel. Multiple abandoned alluvial surfaces, including multiple terrace levels, are evident in the valley, with heights that range from 2 to 9 meters above the modern floodplain. Older alluvial deposits of the Platte have been buried by Peoria and older loess deposits.

**Loess deposits on Judkins Table, Nebraska**

Judkins Table is in the region of thick (> 24 m) loess adjacent to the Sand Hills which lie to directly to the northwest (Fig. 2). The upper portion of the table is primarily Peoria with Bignell Loess is also present on the table and surrounding uplands. The Peoria here is fairly sandy and locally laminated, similar to other loess that is proximal to its source in Nebraska. The Devil’s Den site (see geochronology in Fig. 8) is in the immediate area. This was one of three sites that Roberts et al. (2003) used to show unprecedented mass accumulation rates from ~18-14 ka in the Peoria. Their calculated rates were ~10,500 g m⁻² yr⁻¹ at Devil’s Den and ~11,500 g m⁻² yr⁻¹ at Bignell Hill.

![Fig. 4. Judkins Table and surrounding area. Thick dissected loess is seen in the area around the table and linear dunes are immediately to the north.](image)

**Nebraska Sand Hills and Red River Ranch Beds near Seneca, Nebraska**

The exposure at this site shows eolian dune sand overlying older Pliocene aged sediments along the Middle Loup River. The Pliocene sediments are informally named the Red Ranch beds and include lacustrine, eolian and fluvial facies. These beds underlie a good portion of the Sand Hills, and the sand sheets in these deposits may be a significant source of the sand for the Quaternary age dunes. OSL ages have not been published from this exposure, but one sample collected from the upper portion of the eolian sand yielded an age of 4100 ± 300 years ago.
The Vinton exposure, studied by Mason et al. (2011) shows eolian sand exposed along the upwind end of a barchan dune (Fig. 5). This barchans and others in the area show northwest to southeast migration patterns. The sand in the lower portion shows large-scale cross-bedding that dips at around 30°. OSL ages collected from the lower portions of the exposure were dated to 15.7 ± 1.4 and 16.8 ± 1.3 ka (Fig. 6). These ages are similar to other older ages from other dunes in the Sand Hills that cluster between 17-14 ka. The dune sand in the upper portions of the exposure are approximately 2300 yrs old and are capped by a paleosol. The overlying eolian sand is likely less than 500 years old.

Fig. 5. Topographic map showing location of the Vinton Blowout, and surrounding dunes. Each section (red square) is one square mile.
Fig. 6. Dune stratigraphy and OSL ages from the Vinton Blowout. Upper image shows ages for the older portion of the dunes (Mason et al., 2011), photograph shows unpublished ages done by Swinehart and Goble.

Late Quaternary Loess Geochronology and Stratigraphy at Bignell Hill and Moran Canyon, near North Platte, Nebraska

Loess exposures at Bignell Hill and Moran Canyon have been studied by multiple researchers, and both OSL and radiocarbon chronologies have been published in recent years (Fig. 7). Bignell and Peoria loess are exposed at both sites, and Gilman Canyon is also exposed at Bignell.
Hill. Bignell Hill is a relatively well-studied loess deposit that shows approximately 51 m of Peoria Loess. Radiocarbon, OSL and older TL ages (Maat and Johnson, 1996) from both sites are in good general agreement (see Figs. 8-11). Eolian and is found within the Peoria at both locations, and has been dated to between approximately 20-22 ka. The Brady Soil, which is found at the top of the Peoria, dates to between approximately 14-9 ka. This period corresponds to a hiatus in dune activity in the Sand Hills.

Fig. 7. Location of Bignell Hill and Moran Canyon exposures south of the Platte River valley. This LiDAR-based shaded relief map reveals the dune/sand sheet topography mantled by thick Peoria Loess adjacent to both sections. Square mile sections are present in the bottom southwest portion of the image.
Fig. 8. Loess stratigraphy and geochronology from Bignell Hill, Devil’s Den, and Eustis, Nebraska from Roberts et al. (2003). Radiocarbon ages are from Muhs et al. (1999), Maat and Johnson (1996) and Johnson and Willey (2000).
Fig. 9. Geochronology and loess stratigraphy from Bignell Hill from Muhs et al. (2008). OSL ages from the Peoria are from Roberts et al. (2003), those from Bignell are from Mason et al., 2003. Radiocarbon ages are from Muhs et al. (1999).

Fig. 10. Loess ages from Bignell Hill, County Line Ranch and Moran Canyon indicating the age of the Brady Soil using both OSL and radiocarbon (Mason et al., 2008).
Stratigraphy and Geochronology of the Platte River Valley

Recent studies and geologic mapping have been focused on the long-term evolution of the Platte River valley near the towns of North Platte, Kearney and Grand Island. Results from OSL and radiocarbon dating at the three sites indicate that the Platte River was aggrading during the late Pleistocene and into the early Holocene (see Fig. 12). In the late Pleistocene approximately 8 to 10 meters of sediment was deposited near North Platte, and greater than 15 meters of sediment was deposited near Kearney. During the Holocene the Platte re-worked and locally entrenched into these older alluvial deposits. The total thickness of the Holocene fill ranged from 3 to 8 meters near North Platte, and 10 to 12 meters near Kearney.
Fig. 12. Interpretive geological cross-sections and geochronology in the Platte River valley near the towns of North Platte (upper) and Kearney (lower). Elevations are in meters. Images from Bruihler (2016).

References Cited and Related Readings


Mason, J.A., Miao, X.D., Hanson, P.R., Johnson, W.C., Jacobs, P.M., Goble, R.J., 2008. Loess record of the Pleistocene-Holocene transition on the northern and central Great Plains, USA. Quaternary Science Reviews 27, 1772-1783.


