Data Repository Item

A 10,000-year record of dune activity, dust storms, and severe drought in the central Great Plains

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Methods: Field and laboratory procedures of OSL dating

OSL (or optical dating) determines the timing of deposition of Quaternary sediments, especially for well-bleached eolian deposits. The optical age is obtained by the equation: Optical age (yr) = Equivalent Dose (Gy) / Dose Rate (Gy/yr).
In the single aliquot regenerative (SAR) protocol (Murray and Wintle, 2000), used in this study, multiple aliquots are prepared from a single sample, each of which produces an individual value for the equivalent dose (D_e). After discarding aliquots with unsatisfactory behavior during luminescence measurements, the remaining aliquot D_e values are then combined to determine the final age of the sample.

Samples were collected in aluminum tubes pushed into roadcut exposures or from intact core, and avoiding light exposure is the fundamental requirements during sampling. Additional samples were also taken within a radius of 30 cm around the optical samples to obtain sediment for dose rate estimation by elemental analysis and moisture content determination. Dose rate values were calculated from the bulk sediment concentrations of K, Rb, U, and Th as measured by ICP-MS and ICP-AES, and the dose rate contributed by cosmic radiation was based on equations from Prescott and Hutton (1994). *In situ* water content was measured to correct for its attenuating effect on dose rate.

Samples were opened in the laboratory under dim amber light and wet sieved to separate the 90-125 μm grains. The coarse grains are treated by flotation in 2.7g/cm^3 sodium polytungstate to remove heavy minerals, and hydrofluoric and fluorosilicic acid treatments to etch the quartz and remove feldspars. The isolated quartz grains were then applied to aluminum disks using silicon spray and a 5 mm mask. The quartz aliquots were analyzed with a Daybreak 1150 TL/OSL automated luminescence reader or Risø reader at the University of Nebraska-Lincoln luminescence dating laboratory. Data from individual disks were discarded based on unusual decay curves, poorly corrected sensitivity changes as reflected in the recycling ratio, and poor curve fitting, with an associated error greater than ten percent. The mean of the equivalent doses of the remaining discs was used to calculate the OSL age. Total error estimates incorporate assumed errors of ± 10% in chemical analysis, with an assumed relative variation of ± 30% in water content.

Results

Data used to calculate each OSL age are included in Table DR1. Figure DR1 shows representative histograms of D_e, from both loess and sand. A majority of the optically stimulated luminescence (OSL) ages that are central to this paper have not previously been published (58 of 95 total OSL ages are unpublished). Two new radiocarbon ages are also included. We combine these new data with OSL ages that we have reported in previous papers, to develop the well-dated composite record of aeolian activity presented here for the first time. All previously published ages are identified in the Table DR1.

Fig. DR1. Representative histograms of Equivalent Dose (D_e) for samples of loess and aoelian sand. Mean, median, and midpoint of the modal bin are close, suggestive of a normal distribution, as expected for well-bleached samples.

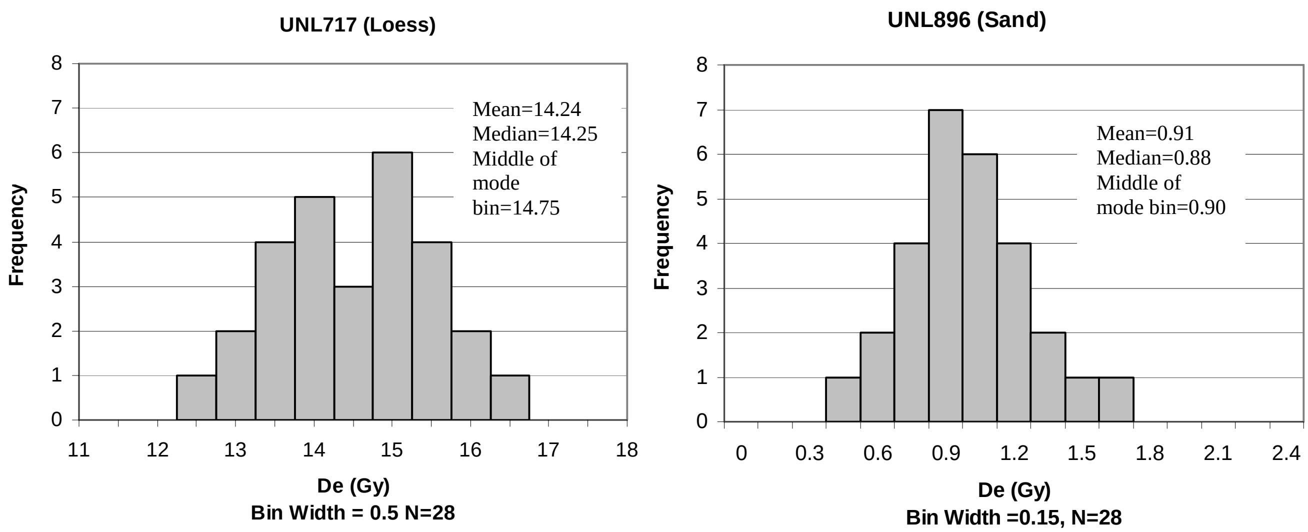

Table DR1. Detailed Optical and Radiocarbon Ages.

A. Loess ages

Depth	Age	De±σ_s	Aliquots	U	Th	K_2O	H_2O	Doserate	Cosm	Lab No	*References*
cm	yr	Gy	n	ppm	ppm	%	%	Gy/1000yr	Gy/1000yr		
1.Old Wauneta Roadcut (OWR) (40°29'59"N, 101°25'10"W, 1018m)											
10	100±10	0.37±0.02	30	2.4	12.4	2.57	4.0%	3.60±0.19	0.25	UNL466	*This study*
27	240±20	0.90±0.02	23	2.4	14.4	2.58	4.3%	3.72±0.19	0.24	UNL467	*This study*
50	560±30	1.97±0.03	24	2.4	13.8	2.43	4.7%	3.55±0.18	0.24	UNL468	*This study*
63	710±40	2.41±0.04	22	2.4	11.8	2.49	6.2%	3.40±0.18	0.23	UNL469	*This study*
140	2580±150	8.66±0.12	25	2.2	11	2.53	4.9%	3.35±0.18	0.21	UNL470	*Miao et al. 2005*
200	3660±220	11.67±0.16	26	2.2	9.8	2.45	5.0%	3.19±0.17	0.19	UNL471	*This study*
250	3890±230	12.53±0.13	26	2.3	9.6	2.49	5.0%	3.22±0.17	0.18	UNL472	*This study*
340	6600±400	20.94±0.26	24	2.3	11.6	2.35	6.6%	3.17±0.17	0.16	UNL473	*Miao et al. 2005*
390	7140±430	25.63±0.47	21	2.8	13.8	2.42	3.8%	3.59±0.19	0.15	UNL546	*Miao et al. 2005*
440	7740±460	27.86±0.46	20	2.9	12	2.58	3.8%	3.60±0.19	0.14	UNL545	*Miao et al. 2005*
490	8190±490	29.25±0.51	29	2.9	12.6	2.51	4.1%	3.57±0.19	0.13	UNL544	*Miao et al. 2005*
540	9090±550	33.17±0.53	29	2.9	13.3	0.15	4.8%	3.65±0.19	0.12	UNL635	*Miao et al. 2005*
590	10250±610	35.16±0.45	23	2.8	12.4	2.41	7.5%	3.43±0.18	0.12	UNL543	*Miao et al. 2005*
2. New Wauneta Road Cut (40°29'59"N, 101°25'10"W, 1018m)											
47	2350±140	8.70±0.13	26	2.6	13.8	2.72	7.5%	3.70±0.20	0.24	UNL427	*Mason et al. 2003*
90	3720±220	14.24±0.19	28	2.9	13.8	2.71	3.4%	3.83±0.20	0.22	UNL717	*This study*
120	4770±290soil	17.84±0.29	24	2.9	14.4	2.53	5.3%	3.74±0.19	0.22	UNL718	*This study*
190	6630±400	23.29±0.43	20	2.6	13.2	2.46	5.4%	3.51±0.18	0.20	UNL426	*Mason et al. 2003*
330	8920±580	30.91±0.31	20	3.1	13.2	2.61	11.8%	3.47±0.21	0.16	UNL425	*Miao et al. 2005*
360	8990±570	31.41±0.59	27	3.1	13.2	2.54	9.4%	3.49±0.20	0.16	UNL424	*Mason et al. 2003*
3. Logan Roadcut (41°28'41"N, 100°18'35"W, 927m)											
32	630±40	2.18±0.03	22	2.6	12	2.53	6.5%	3.49±0.18	0.24	UNL428	*This study*
85	2430±150	7.63±0.13	28	2.4	12.2	2.51	17.5%	3.14±0.17	0.22	UNL539	*This study*
130	3970±240	12.87±0.20	22	2.7	12.8	2.47	7.6%	3.24±0.18	0.21	UNL540	*This study*
330	9500±600	31.49±0.66	20	2.4	12.2	2.51	7.8%	3.31±0.18	0.16	UNL478	*This study*

Logan core											
146	8050±500	24.68±0.38	24	2.3	11.7	2.24	8.9%	3.07±0.17	0.20	UNL668	*Miao et al. 2005*
200	9450±650	30.54±0.60	27	2.8	13.2	2.47	14.4%	3.23±0.20	0.19	UNL669	*Miao et al. 2005*
234	9950±640	29.70±0.52	25	2.8	9.9	2.24	10.5%	2.98±0.17	0.18	UNL670	*Miao et al. 2005*
4. Moran Conyon (41°01'285"N, 100°38'38"W, 890m)											
24	680±50	2.50±0.12	26	2.3	13.6	2.69	6.0%	3.66±0.19	0.24	UNL-529	*Mason et al. 2003*
70	2630±170	8.54±0.24	30	1.9	11.4	2.47	6.0%	3.24±0.17	0.23	UNL-528	*Mason et al. 2003*
210	8780±540	30.82±0.38	24	2.2	13.8	2.57	6.0%	3.51±0.19	0.19	UNL-527	*Mason et al. 2003*
5. Mills (39°59'N, 101°52'W, 1451m)											
82	7400±440	26.61±0.46	21	2.5	12.6	2.61	5.2%	3.59±0.19	0.23	UNL474	*Miao et al. 2005*
123	8350±490	32.24±0.48	25	2.8	13	2.81	4.5%	3.86±0.20	0.21	UNL475	*Miao et al. 2005*
148	9290±560	34.98±0.55	21	2.9	13.6	2.73	6.6%	3.77±0.20	0.21	UNL476	*Miao et al. 2005*
6. County Line Ranch (41°07'56"N, 100°14'42"W, 890m)											
180	6450±400	21.79±0.33	35	2.3	12.4	2.48	6.1%	3.38±0.18	0.19	UNL-530	*Mason et al. 2003*
241	9900±630	29.33±0.48	21	2	8.8	2.35	5.8%	2.96±0.18	0.18	UNL-531	*Mason et al. 2003*
7. Bignell Hill (41°07'56"N, 100°14'42"W, 924m)											
40	9430±560	31.04±0.50	24	2.7	14	1.94	4.0%	3.29±0.17	0.24	UNL-297	*Mason et al. 2003*

B. Eolian Sand Ages

Depth cm	Age yr	De±σ_s Gy	Aliquots n	U ppm	Th ppm	K_2O %	H_2O %	Doserate Gy/1000yr	Cosm Gy/1000yr	Lab No	
a. Gudmundsen Ranch											
Transect #1 - Auger Hole #1 (42°04'03"N, 101°21'49"W, 1084m)											
175	800±75	1.65±0.03	23	0.7	4	1.93	5.6%	2.08±0.06	0.21	UNL-480	*This study*
310	4600±450	9.75±0.16	32	0.7	4	2.02	3.7%	2.12±0.05	0.17	UNL-481	*This study*
450	7725±510	16.91±0.15	35	0.7	4.8	2.01	3.8%	2.19±0.13	0.17	UNL-482	*This study*
580	7990±690	16.58±0.23	32	0.7	4	1.96	3.5%	2.75±0.06	0.12	UNL-483	*This study*
670	7890±715	17.74±0.26	32	0.8	4.6	2.17	4.5%	2.26±0.14	0.18	UNL-652	*This study*
Transect #1 - Auger Hole #2 (42°04'03"N, 101°21'49"W, 1084m)											
610	7540±850	16.71±0.31	33	0.7	4.2	2.16	4.0%	2.21±0.05	0.12	UNL-485	*This study*

Windmill 22 exposure- transect #2 (42°04'10"N, 101°20'59"W, 1056m)											***This study***
100	870±110	2.00±0.05	27	0.8	3.8	2.07	2.9%	2.31±0.06	0.22	UNL-493	*This study*
300	3870±340	9.35±0.13	34	0.9	5.6	2.13	2.5%	2.42±0.06	0.17	UNL-494	*This study*
b. Hwy 91 MP81 linear dune- transect #3 (42°14'26"N, 101°01'56"W, 1013m)											
150	960±140	2.04±0.06	25	0.7	4.6	1.89	2.3%	2.12±0.05	0.20	UNL-487	*This study*
300	920±110	1.88±0.19	20	0.7	4.4	1.87	3.2%	2.05±0.05	0.16	UNL-521	*This study*
400	890±130	1.88±0.06	22	0.8	4.8	1.93	3.0%	2.11±0.05	0.14	UNL-486	*This study*
700	2400±180	4.32±0.07	31	0.6	3.8	1.79	3.6%	2.40±0.17	0.11	UNL-570	*This study*
c.Calamus linear dune (41°51'19"N, 99°15'59"W, 705m)											
400	2570±180	4.67±0.09	32	0.6	3.3	1.77	3.0%	1.81±0.16	0.14	UNL-568	*This study*
200	690±100	1.37±0.03	29	0.6	4	1.83	2.8%	1.99±0.05	0.18	UNL-569	*This study*
d. Calamus - GP03-SH4 (41°51'04N, 99°12'19W, 728m)											
160	620±70	1.39±0.15	15	0.8	5.1	2.20	3.4%	2.26±0.05	0.19	UNL-757	*This study*
185	630±90	1.34±0.14	28	0.8	5.2	2.01	3.8%	2.25±0.05	0.18	UNL-758	*This study*
425	720±100	1.50±0.21	16	0.8	5.4	1.96	3.9%	2.19±0.05	0.14	UNL-762	*This study*
638	2480±260	5.42±0.48	16	0.8	4.9	2.07	4.1%	2.20±0.05	0.10	UNL-771	*This study*
710	2480±150	5.16±0.32	16	0.7	4.1	2.02	4.0%	2.08±0.05	0.10	UNL-774	*This study*
890	2750±310	5.53±0.52	12	0.8	4.2	2.11	4.2%	2.15±0.05	0.08	UNL-775	*This study*
950	2810±300	7.29±0.78	11	1	9.2	2.17	4.3%	2.59±0.07	0.08	UNL-778	*This study*
e. Barta Bros - GP03-SH2 (42°14'30"N, 99°38'43"W, 792m)											
185	880±70	1.61±0.32	15	0.7	3.4	1.64	3.8%	1.83±0.05	0.18	UNL-748	*This study*
215	850±90	1.64±0.22	26	0.7	3.8	1.76	6.7%	1.87±0.05	0.17	UNL-750	*This study*
420	760±130	1.74±0.29	14	0.8	4.5	2.11	3.4%	2.23±0.05	0.14	UNL-779	*This study*
470	720±100	1.63±0.23	17	0.9	5.4	2.04	4.2%	2.25±0.09	0.13	UNL-781	*This study*
640	630±100	1.58±0.24	15	1.1	8.3	2.05	4.3%	2.49±0.06	0.10	UNL-765	*This study*
717	3220±310	7.73±0.70	16	1	6.7	2.12	4.0%	2.40±0.06	0.10	UNL-769	*This study*
895	8150±590	19.59±1.41	20	1	6.2	2.19	3.5%	2.40±0.06	0.08	UNL-782	*This study*
950	7820±590	19.66±1.50	17	1.1	6.7	2.26	4.5%	2.51±0.06	0.07	UNL-785	*This study*
f. Hansen Ranch - 13-A-04 (41°15'27"N, 100°46'34"W,											

935m)											
136	690±50	1.53±0.07	**26**	**0.9**	**5.2**	**2.01**	**6.8%**	2.22±0.06	**0.19**	**UNL-927**	***This study***
290	3160±190	6.57±0.19	**23**	**0.9**	**4.4**	**2.00**	**8.6%**	2.08±0.06	**0.15**	**UNL-928**	***This study***
g.Briefcase wayside, Highway 97 (42°23'28"N, 101°01'52"W, 974m)											
200	1040±70	1.80±0.05	**20**	**0.9**	**4**	**1.43**	**4.5%**	**1.74±0.05**	**0.19**	**UNL-060**	***Goble et al. 2004***
350	3250±200	5.50±0.08	**32**	**0.7**	**4.1**	**1.47**	**4.8%**	**1.69±0.05**	**0.16**	**UNL-062**	***Goble et al. 2004***
h. Kroeger Blowout, south side, northwest of Valentine (42°57'14"N, 101°09'15"W, 994m)											
130	880±50	2.05±0.04	**18**	**1.1**	**5.1**	**2.00**	**4.3%**	**2.32±0.05**	**0.21**	**UNL-067**	***Goble et al. 2004***
630	2430±150	5.96±0.09	**33**	**1.6**	**7.9**	**2.07**	**8.7%**	**2.45±0.07**	**0.11**	**UNL-065**	***Goble et al. 2004***
840	3590±220	8.20±0.15	**10**	**1.5**	**6.3**	**2.01**	**7.9%**	**2.29±0.06**	**0.09**	**UNL-063**	***Goble et al. 2004***
Kroeger Blowout, north side, northwest of Valentine											
130	840±60	2.05±0.06	**15**	**1.2**	**7**	**1.91**	**3.5%**	**2.43±0.06**	**0.21**	**UNL-072**	***Goble et al. 2004***
1200	6180±370	12.36±0.12	**31**	**1.1**	**4.1**	**1.84**	**5.2%**	**2.00±0.05**	**0.06**	**UNL-070**	***Goble et al. 2004***
1230	8430±510	18.50±0.28	**29**	**1.2**	**5.7**	**2.01**	**6.4%**	**2.20±0.05**	**0.06**	**UNL-069**	***Goble et al. 2004***
Yao's Blowout (42°05'11"N, 101°22'03"W, 1059m)											
40	150±10	0.32±0.01	**100**	**0.9**	**4.8**	**1.90**	**4.8%**	**2.19±0.05**	**0.24**	**UNL-051**	***Goble et al. 2004***
100	830±50	1.81±0.01	**134**	**1**	**4.4**	**1.94**	**5.3%**	**2.19±0.05**	**0.22**	**UNL-053**	***Goble et al. 2004***
630	830±50	1.69±0.04	**20**	**1**	**5.6**	**1.84**	**8.3%**	**2.03±0.05**	**0.11**	**UNL-054**	***Goble et al. 2004***
850	3820±240	7.08±0.12	**28**	**0.8**	**3.5**	**1.81**	**5.2%**	**1.85±0.05**	**0.09**	**UNL-056**	***Goble et al. 2004***
j. Diamond Bar Ranch - 14-A-04 (41°31'52"N, 100°30'10"W, 915m)											
136	830±50	1.80±0.05	**27**	**0.8**	**4.3**	**1.86**	**1.0%**	**2.16±0.05**	**0.21**	**UNL-929**	***This study***
817	1060±70	1.98±0.09	**20**	**0.7**	**3.4**	**1.83**	**3.8%**	**1.87±0.05**	**0.09**	**UNL-930**	***This study***
k.Merritt Reservoir (42°37'50"N, 100°52'05"W, 916m)											
300	9010±630	20.97±0.84	**16**	**1.5**	**7**	**1.76**	**2.8%**	**2.32±0.06**	**0.17**	**UNL-641**	***This study***
l.Collier Ranch (41°46'42"N, 100°18'.27"W, 841m)											
700	830±130	**1.50±0.25**	**28**	**0.8**	**3.9**	**1.69**	**3.9%**	**1.83±0.04**	**0.10**	**UNL-645**	***This study***
700	4400±450	**7.70±0.90**	**32**	**0.7**	**3.3**	**1.64**	**5.0%**	**1.71±0.04**	**0.10**	**UNL-648**	***This study***
m.Crescent Lake C3T (41°49'53"N, 102°34'32"W, 1209m)											

50	500±40	0.91±0.05	28	0.7	2.9	1.59	3.0%	1.81±0.05	0.23	UNL-896	*This study*
530	1100±70	1.98±0.07	20	0.8	2.7	1.76	5.2%	1.79±0.05	0.12	UNL-900	*This study*
790	2830±180	4.62±0.18	23	0.7	3.4	1.51	3.5%	1.64±0.04	0.09	UNL-902	*This study*
980	4480±270	9.28±0.33	26	0.9	4.8	1.95	4.9%	2.07±0.05	0.08	UNL-898	*This study*
1030	5650±370	10.13±0.44	21	0.8	3.4	1.71	3.6%	1.79±0.04	0.07	UNL-899	*This study*
n.Johnson Ranch (42°42'04"N, 100°04'30"W, 782m)											
440	980±70	1.98±0.11	20	0.7	4.5	1.89	4.1%	2.03±0.05	0.14	UNL-973	*This study*
870	3260±180	6.50±0.13	24	0.8	4.5	1.92	5.4%	1.99±0.05	0.09	UNL-976	*This study*
1000	4340±240	7.81±0.15	22	0.8	3.8	1.83	9.3%	1.79±0.06	0.07	UNL-979	*This study*

C. Radiocarbon ages

	Depth (cm)	^{14}C age (BP)	cal yr BP (Calib 4.4, 2σ)	$\delta^{13}C$	Dating Material	Lab No	
1. Wauneta Core	153	1640±40	1510-1690	-23.20	Charcoal	Beta-194879	*This study*
2. Old Wauneta Roadcut	280	4080±25	4445-4806	-18.45	Humic acid (From OM)	UCIAMS-11694	*This study*

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