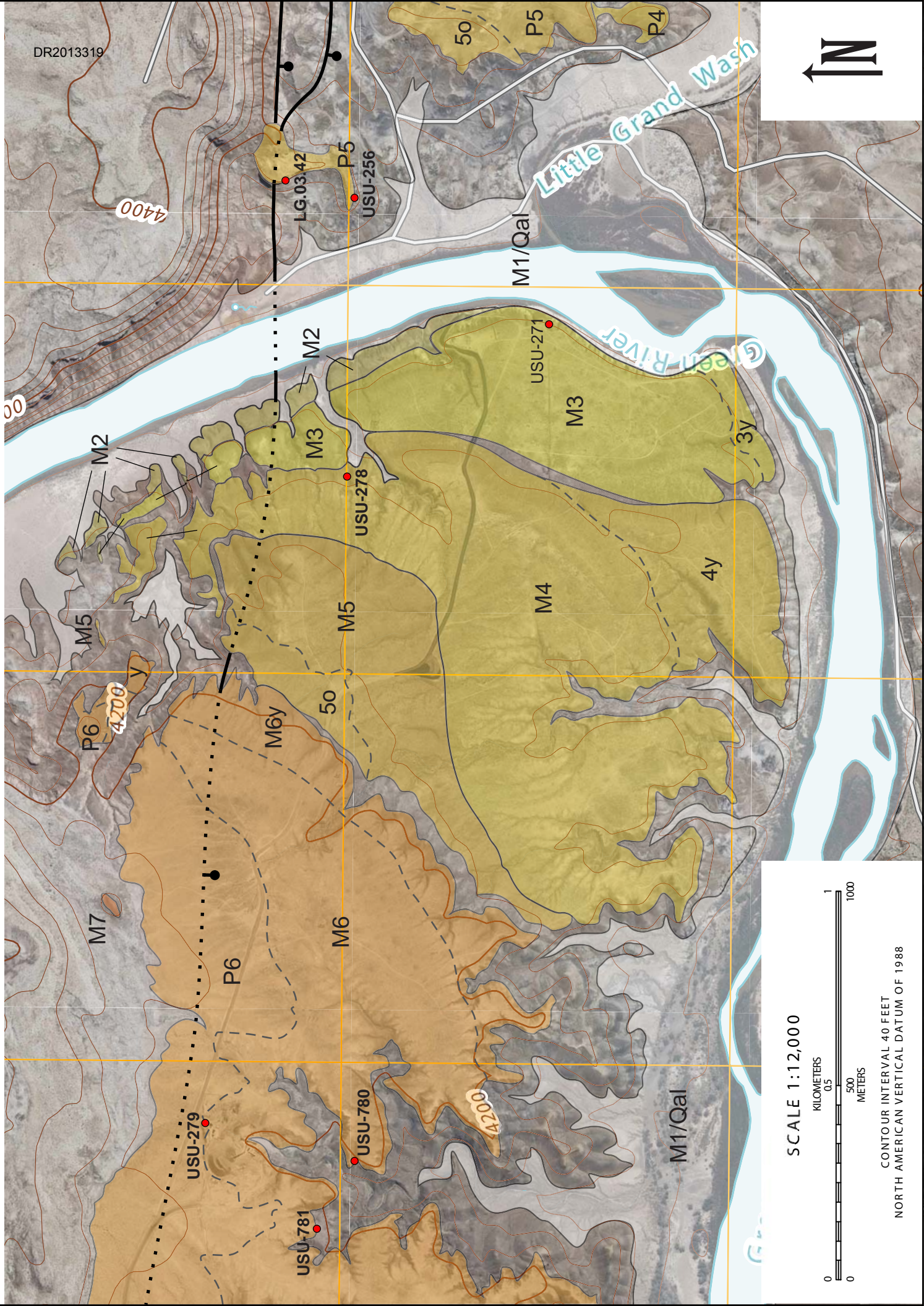


# Pleistocene Terrace Deposits of the Crystal Geyser Area

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SCALE 1:12,000



CONTOUR INTERVAL 40 FEET  
NORTH AMERICAN VERTICAL DATUM OF 1988

## Data Repository Item 2: OSL methods and full results

### METHODS

All samples were opened and processed under dim, amber safelight (590 nm wavelength) conditions within the Utah State University Luminescence Laboratory. Sample processing followed standard procedures involving sieving, treatment with HCl and bleach to remove carbonates and organics, gravity separation using sodium polytungstate ( $2.7 \text{ g/cm}^3$ ) to separate quartz and feldspar from heavy minerals and 47% HF (three 30-minute treatments) to isolate the quartz component. Samples were then re-sieved to remove  $<75 \mu\text{m}$  partially-dissolved feldspar grains, and sample purity of each aliquot was checked by IRSL response. Sample processing procedures follow those outlined in Aitken (1998) and described in Rittenour et al. (2005).

Dose-rate calculations were determined by chemical analysis of the U, Th, K and Rb content using ICP-MS and ICP-AES techniques by ALS Chemex, Inc. and utilizing conversion factors from Guerin et al. (2011). The contribution of cosmic radiation to the dose rate was calculated using sample depth, elevation, and latitude/longitude following Prescott and Hutton (1994). Dose rate was calculated based on water content, sediment chemistry, and cosmic contribution (Aitken, 1998).

Small aliquots (2-mm or  $<100$  grains) of quartz sand were analyzed using the single-aliquot regenerative-dose (SAR) procedure (Murray and Wintle, 2000) on Risø TL/OSL-DA-20 readers with blue-green ( $470 \pm 30 \text{ nm}$ ) light emitting diodes (LED) and stimulation at  $36 \text{ W/m}^2$  LED power at  $125^\circ\text{C}$  over 40 s (250 channels), with detection through 7.5 mm Hoya U-340 filters. OSL measurements followed  $240^\circ\text{C}$  preheat and  $160^\circ\text{C}$  cutheat thermal treatments. Criteria for the rejection of aliquots include aliquots responding to infra-red stimulation and those with  $>10\%$  recuperated signals above the natural when no dose was given and recycling ratios  $>10\%$  of the repeated dose. Resultant ages were calculated using the Central Age Model (CAM) of Galbraith et al. (1999) on accepted aliquots. The CAM was used for all samples because overdispersion values are  $< 30\%$  and all samples lack significant skew in equivalent dose distributions (modified from criteria of Arnold et al. 2007). OSL age results are reported at  $2\sigma$  standard error and include both random and systematic error calculated in quadrature.

DR2 Table 1 below presents age and equivalent dose data, and DR Table 2 is full data used to calculate dose rate. Then signal-decay curves and dose-response curves for three representative samples are shown in DR2 Figure 1. Finally, Equivalent dose ( $D_e$ ) distributions are illustrated and overdispersion (OD) and skew statistics are given for each sample in DR2 Figure 2.



**DR2 Table 1. Crystal Geyser OSL Age Information<sup>a</sup>**

Sample #	Deposit	Aliquots <sup>b</sup>	Equivalent dose <sup>c</sup> (Gy)	Overdispersion <sup>d</sup> (%)	Dose Rate (Gy/ky)	OSL Age <sup>e</sup> (ka)
USU-256	P6/5	34 (45)	187.39 ± 15.03	19.4 ± 3.3	2.15 ± 0.12	<b>87.3 ± 11.2</b>
USU-271	M3	27 (35)	118.03 ± 12.12	20.1 ± 4.4	2.83 ± 0.16	<b>41.8 ± 6.0</b>
USU-278	M4	27 (43)	145.72 ± 15.31	23.4 ± 4.2	3.67 ± 0.21 <sup>f</sup>	<b>39.7 ± 5.8<sup>f</sup></b>
USU-279	P6/5	25 (45)	222.81 ± 17.45	16.4 ± 3.3	2.66 ± 0.14	<b>83.9 ± 10.6</b>
USU-780	M6	24 (48)	232.27 ± 32.20	28.1 ± 5.7	2.40 ± 0.13	<b>96.8 ± 16.5</b>
USU-781	M6	27 (41)	227.79 ± 17.27	14.9 ± 3.4	2.29 ± 0.12	<b>99.4 ± 12.4</b>

<sup>a</sup> Age analysis using the single-aliquot regenerative-dose procedure of Murray and Wintle (2000) on 2-mm small-aliquots of quartz sand utilizing a RISO TL/OSL-DA-20 reader with blue-green light stimulation (470 nm, 36 W/cm<sup>2</sup>, Hoya U340 filter).

<sup>b</sup> Number of aliquots used in age calculation, with total number of aliquots analyzed in parentheses.

<sup>c</sup> Error on equivalent dose is 2-sigma standard error, calculated using the Central Age Model of Galbraith et al. (1999).

<sup>d</sup> Overdispersion represents scatter in equivalent dose beyond calculated uncertainties in data, values over 20% represent significant scatter.

<sup>e</sup> Error on age is 2-sigma standard error.

<sup>f</sup> Erroneously high dose rate and thus low age estimate, see text and detailed dose rate information below.

**DR2 Table 2. Crystal Geyser Dose Rate Information<sup>a</sup>**

Sample #	Deposit	Depth (m)	Grain size (μm)	H <sub>2</sub> O% <sup>b</sup>	U (ppm) <sup>c</sup>	Th (ppm) <sup>c</sup>	%K <sup>c</sup>	Rb (ppm) <sup>c</sup>	Cosmic (Gy/ky) <sup>d</sup>	Dose Rate (Gy/ky) <sup>e</sup>
USU-256	P6/5	4.0	75-150	1.6	1.7 ± 0.1	5.7 ± 0.5	1.22 ± 0.03	61.6 ± 2.5	0.16 ± 0.02	2.15 ± 0.12
USU-271	M3	3.0	90-150	0.8	2.2 ± 0.2	11.4 ± 1.0 <sup>f</sup>	1.38 ± 0.03	51.3 ± 2.1	0.16 ± 0.02	2.83 ± 0.16
USU-278 <sup>f</sup>	M4	1.7	90-150	3.6	4.4 ± 0.3	16.2 ± 1.5 <sup>f</sup>	1.38 ± 0.03	51.5 ± 2.1	0.20 ± 0.02	3.67 ± 0.21 <sup>g</sup>
USU-279	P6/5	2.5	90-150	1.2	2.4 ± 0.2	7.4 ± 0.7	1.43 ± 0.04	53.3 ± 2.1	0.19 ± 0.02	2.66 ± 0.14
USU-780	M6	2.5	150-250	4.2	2.2 ± 0.2	4.3 ± 0.4	1.53 ± 0.04	51.5 ± 2.1	0.19 ± 0.02	2.40 ± 0.13
USU-781	M6	1.9	150-250	3.3	2.0 ± 0.1	3.6 ± 0.3	1.47 ± 0.04	49.5 ± 2.0	0.21 ± 0.02	2.29 ± 0.12

<sup>a</sup> Radioelemental concentrations by ICP-MS and ICP-AES at ALS Chemex, dose rate using conversion factors in Aitken (1985), Adamiec and Aitken (1998).

<sup>b</sup> In-situ water content, 3±3% used for samples with <3% measured moisture.

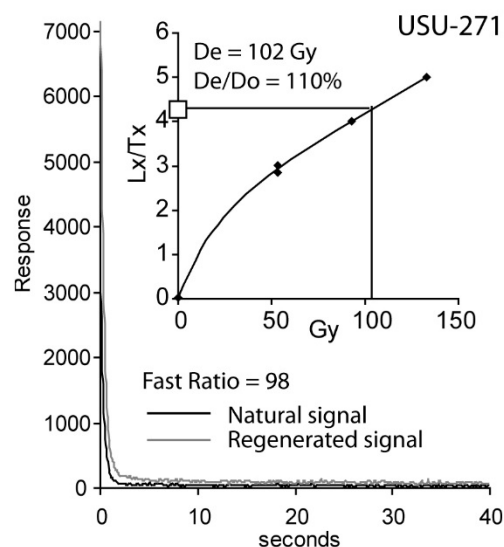
<sup>c</sup> Errors on concentration values are based on detection limits and follow those described in Rittenour et al. (2005).

<sup>d</sup> Contribution of cosmic radiation to dose rate is calculated using sample depth, elevation, and lat/long following Prescott and Hutton (1994).

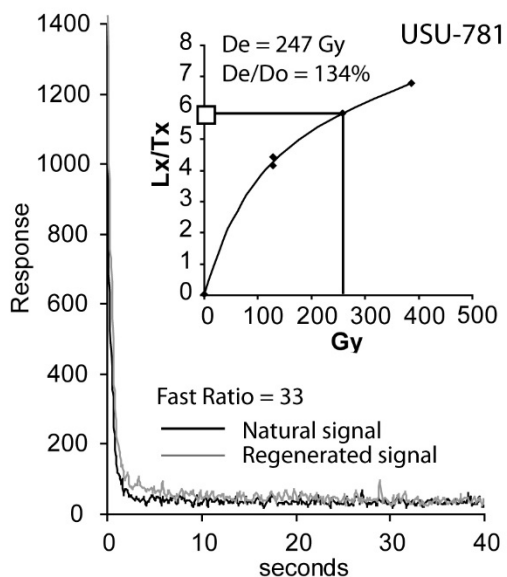
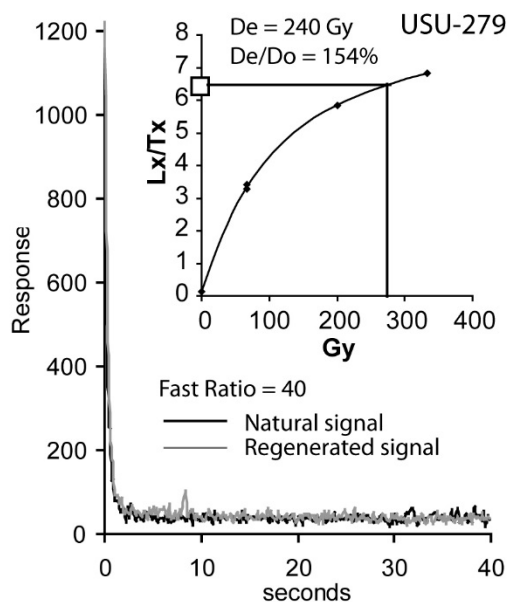
<sup>e</sup> Dose rate was calculated assuming a 2.0 g/cm<sup>3</sup> sample density, and using water content and reported grain size

<sup>f</sup> Elevated Th concentrations in these samples and low U:Th ratios suggest possible disequilibrium in the U-series decay chain.

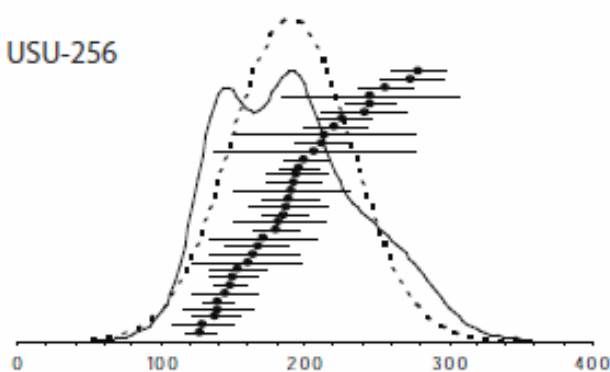
<sup>g</sup> Sample data are mean of three independent analyses. Final dose rate value is interpreted as inflated by recent translocation of U and Th via gypsum into the soil profile.



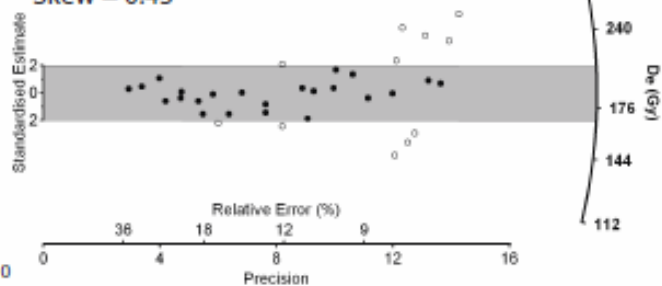
**DR2 Figure 1.** Luminescence decay curves and dose-response curves for representative samples in dataset. Fast ratios  $>20$  are indicative of samples dominated by fast-decaying quartz luminescence signals. Ratios of the equivalent dose to the point on the exponential curve where the response begins a saturating form ( $De/Do$ )  $<200\%$  are considered acceptable for accurate calculations (Wintle and Murray, 2006). All samples in the dataset are dominated by the fast component and all have acceptably low  $De/Do$ .



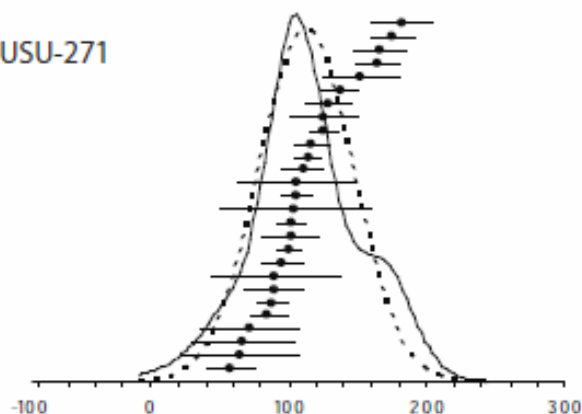
USU-256



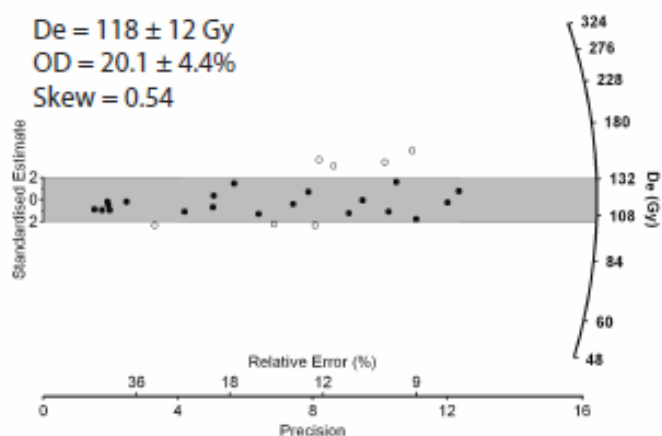
De =  $187 \pm 15$  Gy  
OD =  $19.4 \pm 3.3\%$   
Skew = 0.45



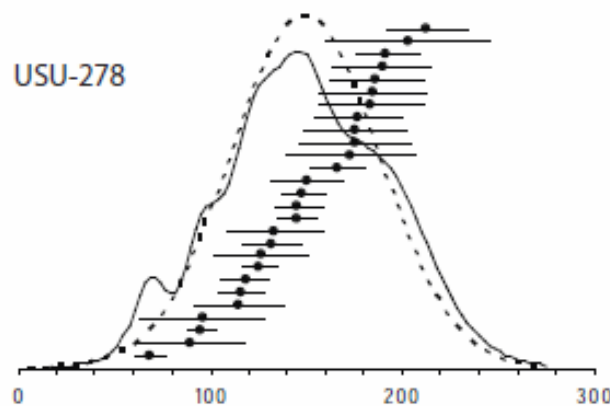
USU-271



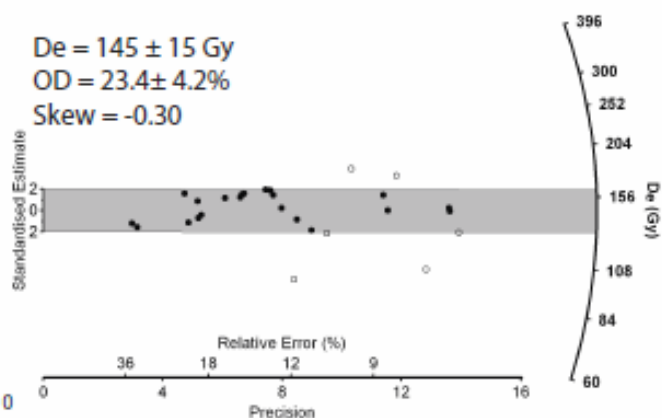
De =  $118 \pm 12$  Gy  
OD =  $20.1 \pm 4.4\%$   
Skew = 0.54



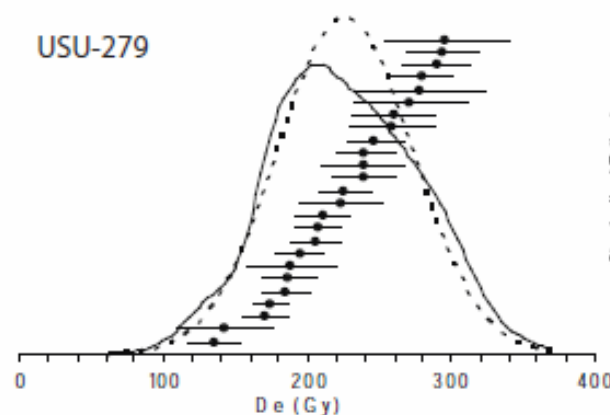
USU-278



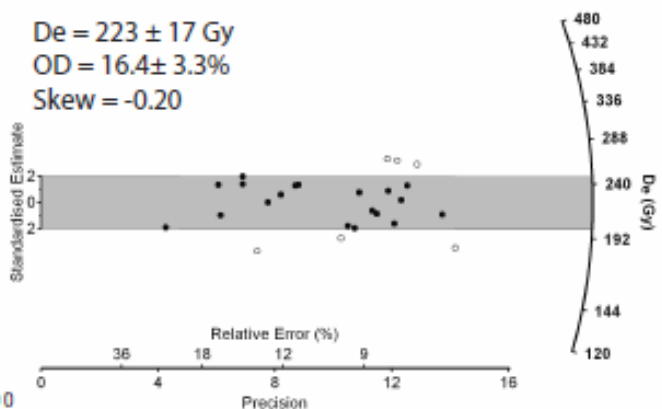
De =  $145 \pm 15$  Gy  
OD =  $23.4 \pm 4.2\%$   
Skew = -0.30

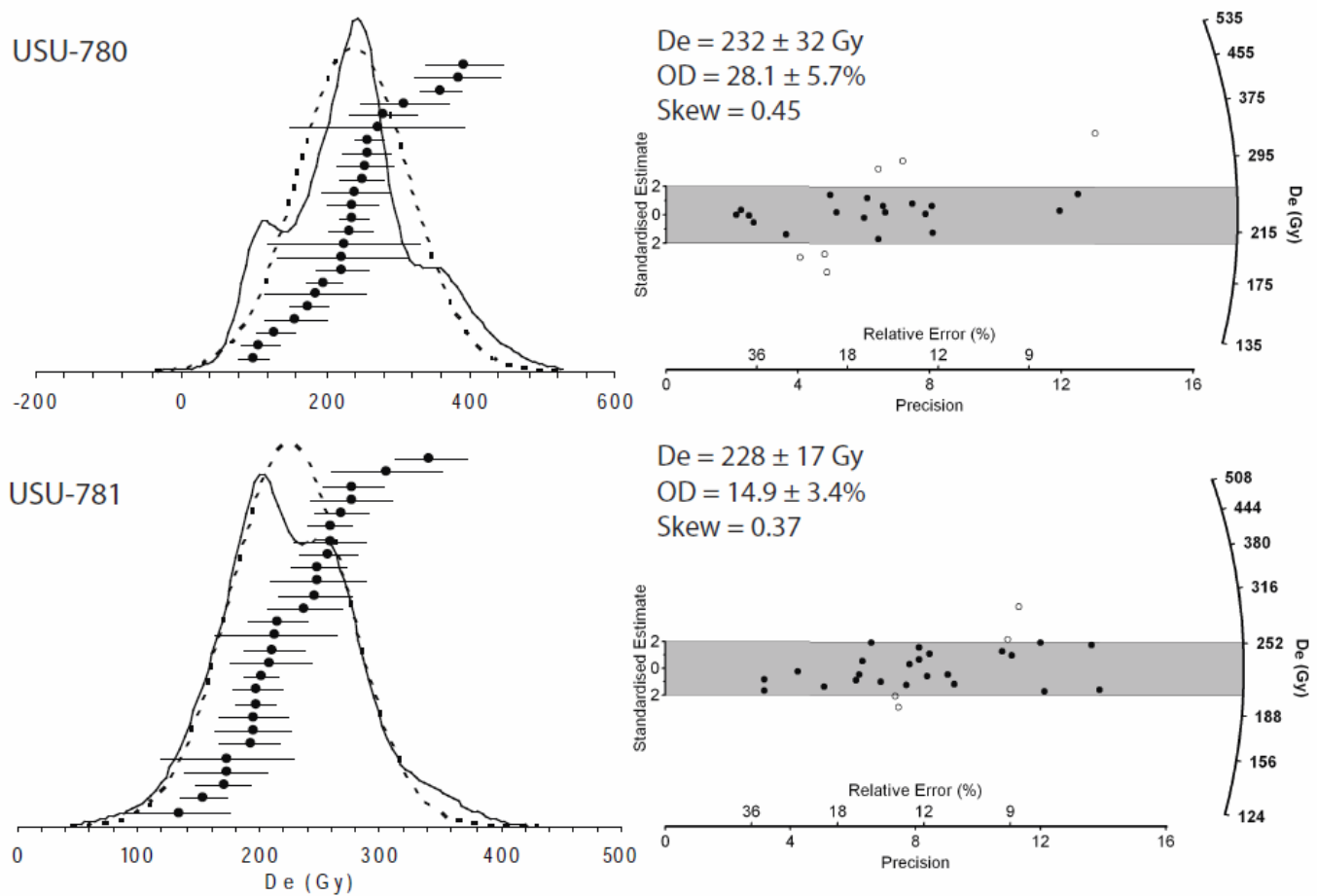


USU-279



De =  $223 \pm 17$  Gy  
OD =  $16.4 \pm 3.3\%$   
Skew = -0.20





**DR2 Figure 2.** Equivalent dose (De) distributions for samples. Data are shown as probability density functions (left) and radial plots (right). Statistics of overdispersion (OD) and skew are also presented. None of the De distributions are significantly skewed (following Arnold et al. 2007)

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