Supplemental Material: OSL Dating Methods for Sandy Springs

Landform chronology reconstruction was based on eight samples submitted for OSL dating (Aitken, 1998) at the Geoluminescence Dating Research Lab at Baylor University. Single aliquot regeneration (SAR) protocols (Murray and Wintle, 2003) were used for OSL dating to estimate the apparent equivalent dose of the 63-44, 250-355, 355-425, and 425-500 µm quartz fractions for 28 to 61 separate aliquots. Each aliquot contained approximately 100 quartz grains corresponding to a 1.5 mm to 2.0 mm circular diameter of grains adhered (with silicon) to a 1 cm diameter circular aluminum disc. These samples were mineralogically mature with SiO_2 content of 70% to 90% of the non-carbonate fraction and are predominantly (>80%) well-sorted quartz grains. The quartz fraction was isolated by density separations using the heavy liquid Na–polytungstate. Subsequently, the outer ~10 µm of grains were etched by a 40-min immersion in HF (40%) to remove grain area most effected by alpha radiation (Mejdahl and Christiansen, 1994). Next, these grains were soaked HCl (10%) for 8 hrs to eliminate fluorides. The purity of the quartz fraction was guaged by petrographic inspection with point counting of 100-200 grains. Samples that yielded >1% of non-quartz minerals were retreated with HF and rechecked petrographically. Aliquot quartz purity was also tested by infrared excitation (845 ± 4 nm), which preferentially excites feldspar minerals, rather than quartz. All samples exposed to infrared light showed low light levels (<200 counts/s) at or near to background counts and with a blue to infrared emission ratio of >20, indicating a spectrally pure quartz separate (Duller et al., 2003).

Experiments were undertaken to evaluate the effect of preheating at 200, 220, 240 and 260 °C on isolating the most robust time-sensitive emissions and thermal transfer of the regenerative signal prior to the application of SAR dating protocols (see Murray & Wintle, 2003). These experiments entailed giving a known dose (20 Gy) and evaluating which preheat resulted in recovery of this dose. There was agreement between the known and recovered dose (20 Gy) for preheat temperatures above 220 °C with an initial preheat temperature used of 220 °C for 40 s in the SAR protocols. A "cut heat" at 220 °C for 40 s was applied prior to the measurement of the test dose and a final thermal wash at 260 °C for 40 s to minimize carryover of luminescence to the next sequence of regenerative doses (see Table 4, main text). A test for dose reproducibility was also performed following procedures of Murray and Wintle (2003) with the initial and final regenerative dose of ~16 Gy yielding concordant luminescence responses (at one-sigma error).

A typical OSL shine-down curves for quartz grains are shown in Figure S1. This emission signal indicates a dominance by a fast component, decreasing by 90 to 95% during the first 4 s of blue-excitation. The regenerative growth curves are modeled by using the exponential plus linear form. For many aliquots the regenerative growth curves (Figure S1) indicate that (1) the recuperation is close to zero; (2) the recycling ratio is consistent with unity at 1σ; (3) the natural Lx/Tx ratio is within 20% of the saturated level. Some aliquots were removed because of unacceptable recycling ratio and De values at or close to saturation with errors of >10%. Error analysis for equivalent dose calculations assumed measurement error of 1% and Monte Carlo simulation repeats of 2000. Recuperation is lower than 3% for all samples, which indicates insignificant charge transfer during the measurements. These favorable luminescence characteristics for a majority of aliquots indicate that credible equivalent dose values for these sediments can be determined by the SAR protocol.

Equivalent (D_e) dose by SAR protocols was calculated for 23 to 60 aliquots. The statistical distribution of De values was log normal and the distribution of D_e values is approximate by overdispersion value (Table 4; Figure S1). An overdispersion percentage of a De distribution is an estimate of the relative standard deviation from a central De value in context of a statistical estimate of errors (Galbraith et al., 1999; Galbraith and Roberts, 2012). Overdispersion values ≤ 20% are commonly determined for quartz grains that are fully solar reset, such as aeolian sediment (e.g., Wright et al., 2011). Thus, overdispersion values < 20% are a threshold metric for calculation of a De value using the central age model (Galbraith et al. 1999). In contrast overdispersion values >20% indicate mixing or grains of various ages or partial solar resetting of grains. The minimum age model is an appropriate statistical treatment for such data and effectively weights for the youngest De distribution. However, some studies have concluded that overdispersion values between 20 and 32% may reflect a single De population, particularly if the De distribution is symmetrical, with the dispersion related to variability associated with micro-dosimetry and/or sedimentary processes (e.g., Arnold & Roberts, 2009). We consider overdispersion values >20% (at one sigma limits) to indicate post depositional mixing of grains of various ages, partial solar resetting of grains or complex microdosimetry; the Finite Mixture Model (FMM) is an appropriate statistical treatment for such data (Galbraith and Green, 1990), and this model was used for quartz extracts that yielded overdispersion values of 25% (Table S1).

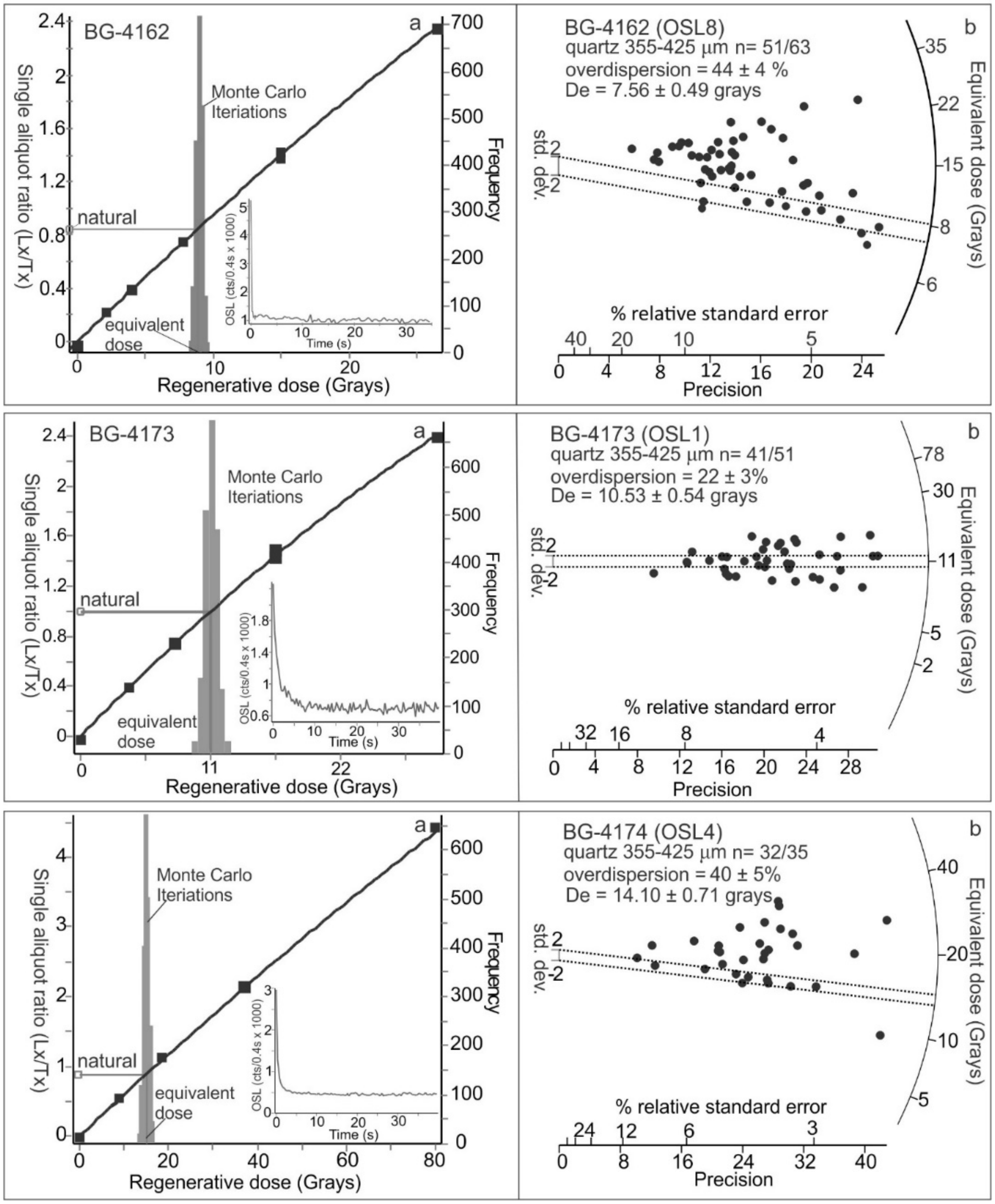

Figure S1. Representative regenerative dose growth curves, with inset representative natural shine down curve, and radial plots of equivalent dose values on small aliquots (2-mm plate of 44-500 µm quartz fraction grains, see Table 1).

Table S1. Single Aliquot Regeneration Protocols

Step	Treatment
1	Natural dose or give beta dose
2	Preheat 240ºC for 10 s
3	Stimulate with blue light (470 nm) for 40 s at 125ºC
4	Give beta test dose (6.6 Gray)
5	Preheat 240ºC for 10 s
6	Stimulate with blue light (470 nm) for 40s at 125ºC
7	Stimulate with blue light for 40 s at 280ºC
8	Return to step 1

The environmental dose rate (D_r) is an needed assessment to calculate an OSL age. The D_r is an estimate of the exposure of quartz grains to ionizing radiation from the decay of the U and Th series, ^{40}K, and cosmic sources during the burial period. The U, Th, Rb and K content are determined by inductively coupled plasma mass spectrometry by Activation Laboratory LTD, Ancaster, Ontario, Canada on the bulk sediment. The beta and gamma doses were adjusted according to grain diameter to compensate for mass attenuation for the dose rate (Fain et al., 1999). Beta and gamma attenuation coefficients for 355 to 425 µm are 0.800 and 0.997, respectively. A cosmic dose rate component was calculated on the basis of location, elevation and depth of strata sampled and is between 0.16 and 0.20 mGy/yr (Prescott and Hutton, 1994). There is uncertainty in assessing the moisture content of a sample during the burial period. We estimated moisture contents from present values, particle size characteristics and in reference to the height of the water table.

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