Supplemental Text

Optically stimulated luminescence (OSL) dating was performed on quartz sand at the Luminescence and Gamma Spectrometry Laboratory (LEGaL) at the University of São Paulo. Under subdued red light, samples were wet-sieved to separate the 180-250 µm grain-size fraction. After sieving, the target fraction was treated with 27% H2O2 to remove organic matter and 3.7% HCl to dissolve any carbonates. Heavy mineral (> 2.75 g/cm3) and feldspar (< 2.62 g/cm3) grains were removed by density separation with lithium metatungstate solution. The samples were etched with 38% HF for 40 min to remove remnant feldspars and etch a ~10 µm outer layer of the quartz grains, thus removing the contribution of alpha particles to the dose rate.

Luminescence measurements were carried out on an automated Risø TL/OSL DA-20 reader system, equipped with a 90Sr/90Y beta source and blue LEDs (470±20 nm) operated at 90% power (~40 mW/cm) for stimulation. The near UV emissions were measured with a bialkali PM tube (Thorn EMI 9635QB) coupled with Hoya U-340 detection filters (290-340 nm). Aliquots of quartz grains were mounted on stainless steel cups with 4 mm diameter contain about 100-200 grains. Equivalent doses for each aliquot were determined using the single aliquot regenerative dose (SAR) procedure (Supplementary Table 1; Murray and Wintle, 2000). The SAR protocol performance was evaluated by the routine tests suggested by Murray and Wintle (2000; 2003), where only aliquots with a recycling ratio between 0.90-1.10, recuperation less than 5%, and negligible feldspar signal tested by infrared stimulation were used in equivalent dose calculations. Equivalent doses for each sample were calculated using the central age model (Galbraith et al., 1999).

Radionuclides concentrations were determined by gamma ray spectrometry using a Canberra Industries high-purity germanium (HPGe) detector encased in an ultralow background shield, with 55% relative efficiency and 2.1 keV of energy resolution. Each sample was dried and packed in sealed plastic containers and stored for at least 28 days to allow radon to reach equilibrium with its parent radionuclides, prior to gamma spectrometry measurement. Beta and gamma radiation dose rates were determined using radionuclides concentrations (U, Th and K) and conversion factors outlined by Guérin et al. (2011). Because the samples were air dried following core sampling, the water content was estimated in the laboratory. For each sample, a known volume of dried material was weighed, fully saturated with water, and then weighed once again. The weight difference was assumed to the maximum water content for each the sample, and the average value of 20±5% was applied to all samples. The cosmic dose rate contribution was calculated following Prescott and Hutton (1994).