GSA DATA REPOSITORY ITEM 2001093—OPTICALLY STIMULATED LUMINESCENCE (OSL) DATING RESULTS

TABLE A. SUMMARY OF OPTICALLY STIMULATED LUMINESCENCE (OSL)
DATING RESULTS FROM QUARTZ MINERALS

Sample #	Size (μm)	U[1] (ppm)	Th[1] (ppm)	K[1] (%)	Rb[1] (ppm)	$W_{in\text{-}situ}$[2] (%)	Cosmic[3] (mGya^{-1})	Dose-rate[4] (mGya^{-1})	D_e[5] (Gy)	Age[6] (ka)
OVF2-8	90-125	3.06	14.10	3.02	125	1.8	0.211	4.82±0.32	11.95±0.90	2.5±0.3
OVF2-5	90-125	3.15	10.70	2.89	126	2.3	0.211	4.46±0.30	14.85±1.11	3.3±0.3
OVF2-9	125-180	6.84	14.20	3.07	135	5.9	0.186	5.43±0.33	20.58±1.23	3.8±0.3
OVF2-7	90-125	10.8	14.60	2.92	134	12.8	0.178	5.80±0.34	23.04±1.55	4.0±0.4
OVF2-6	125-180	2.31	10.10	2.96	132	2.5	0.194	4.23±0.29	12.81–59.10[7]	3.0–14.0[7]

[1]Elemental concentrations from NAA of whole sediment measured at Becquerel Laboratories, Lucas Heights, NSW, Australia. Uncertainty taken as ±10%.

[2]Estimated fractional water content from whole sediment (Aitken, 1998). Uncertainty taken as ±5%.

[3]Estimated contribution to dose-rate from cosmic rays calculated according to Prescott and Hutton (1994). Uncertainty taken as ±10%.

[4]Total dose-rate from beta, gamma and cosmic components. Beta attenuation factors for U, Th and K compositions calculated using Rainer Grün's "Age" program incorporating grain size factors from Mejdahl (1979). Beta attenuation factor for Rb arbitrarily taken as 0.75 (cf. Adamiec and Aitken, 1998). Factors utilized to convert elemental concentrations to beta and gamma dose-rates from Adamiec and Aitken (1998) and beta and gamma components attenuated for moisture content.

[5]Mean equivalent dose (D_e) determined from replicated single-aliquot regenerative-dose (SAR; Murray and Wintle, 2000) runs. Errors are 1-sigma standard errors (i.e. $\sigma_{n-1}/n^{\frac{1}{2}}$) incorporating error from laboratory beta source estimated at about ±5%.

[6]Relative sample positions discussed in the text and Fig. 2 of the main article. Errors are 1σ.

[7]The D_e results for OVF2-6 are distributed indicating substantial heterogeneous partial bleaching. Therefore, the OSL age is bracketed between the minimum and maximum D_e results corresponding to an age range of about 3.0 to 14.0 ka.

Sampling and preparation

Five samples (Table A) were collected from the trench at the Goodale Road site in the northern region of the Owens Valley fault zone (118°1.1'W, 36°58'N). The samples were obtained by hammering opaque plastic tubes into cleaned sections. Once removed the tubes were sealed in plastic and placed in light-tight sampling bags.

In the laboratory estimates of *in-situ* water content (mass of moisture/dry mass; Aitken, 1998) were obtained on sub-samples using a 50°C oven. A number of physical and chemical preparation techniques were then employed to derive quartz grains with a near-uniform grain-size with luminescence due to alpha particle irradiation removed. The samples were dry sieved, carbonates were removed with HCl, organic material was removed with H_2O_2, quartz and feldspar-rich fractions were separated with heavy liquids and a centrifuge, and finally the quartz-rich fractions were treated with HF to dissolve plagioclase feldspars and remove the alpha-irradiated surface of the quartz grains. Dried quartz grains were mounted on stainless steel discs with silicon grease. All the preparation techniques were carried out under laboratory safelights to avoid sample bleaching.

Environmental radiation dose-rate

About 20 g of a dried sub-sample from each sediment sample was ground to a fine powder and sent to the Becquerel Laboratories at Lucas Heights in Australia for Neutron Activation Analysis (NAA). Using appropriate dose-rate conversion factors (Adamiec and Aitken, 1998) and moisture attenuation factors (Aitken, 1998) the elemental concentrations were converted into external beta and gamma components. These were summed together with a cosmic ray

component (estimated from Prescott and Hutton, 1994) to give estimates of the total dose-rate (Table A) for each sample.

Luminescence measurement and estimation of equivalent dose (D_e)

Luminescence measurements were carried out using a Daybreak 1100 automated system with an 1100FO/L combined fibre-optic/IRLED illuminator for optical stimulation (Bortolot, 1997). Luminescence from the quartz grains was stimulated with green light (514Δ34 nm; ~20mWcm^{-2}) from a 150 W halogen lamp defined by a narrow band interference filter. All quartz samples were screened for feldspar contamination using infrared stimulation from T-1 GaAlAs diodes (880Δ80 nm; diode current 20 mA). All OSL signals were detected with a PMT characterized by 9 mm Schott UG11 ultraviolet detection filters. Daybreak TLApplic 4.26 software was used for hardware control and equivalent dose (D_e) analysis.

Equivalent dose (D_e) measurements were determined using the single-aliquot regenerative-dose (SAR) protocol (Murray and Wintle, 2000). In the SAR method, each natural or regenerated OSL signal is corrected for changes in luminescence sensitivity using the OSL response to a subsequent test dose. The natural dose (N) was measured in the first cycle, and thereafter five regeneration doses (R_1 to R_5) were administered. The first three were used to bracket the natural luminescence level ($R_1 < N \sim R_2 < R_3$), the fourth (R_4) was zero to monitor recuperation (ie. R_4/N), and the fifth dose was equal to the first to monitor reproducibility (ie. R_5/R_1) of sensitivity corrections. Each measurement cycle comprised a regeneration dose (zero for natural), a preheat of 200°C for 10 s, stimulation for 100 s (sample temperature of 125°C), a constant test-dose, a test-preheat of 160°C for 0 s and a final stimulation for 100 s (at 125°C). The net-natural and net-regenerated OSL were derived by taking the initial OSL signal (0-1 s) and subtracting a background from the last part of the stimulation curve (90-100 s); the net-test-dose response was derived by subtracting the background from the preceding natural and regenerative OSL signals.

Eight SAR measurements were completed for each sample. Growth curves were plotted using the net natural and regenerated data divided by the subsequent response to the net-test dose (Fig. A). The growth curve data was fitted with a single saturating exponential function. Two rejection criteria were utilized; if recuperation was >5% of the natural level and if the miss-match between repeat regenerative levels was >10%. If a disc failed to meet these criteria it was discarded and a new disc measured. The mean D_e data from the eight repeats was analyzed using the QA method developed by Clarke et al. (1999) adapted to the sensitivity-corrected data from SAR results. In certain cases discarding individual D_e results, which varied significantly from a central cluster, dramatically improved the fractional error in the mean, S_N (such that $S_N = \sigma_{n-1}$/mean-D_e, where σ_{n-1} is the standard deviation) whereas the mean D_e value varied by a negligible amount. The improved data set was used to calculate final ages (Table A) in these instances.
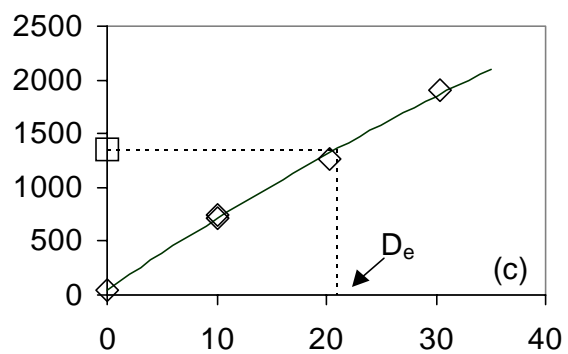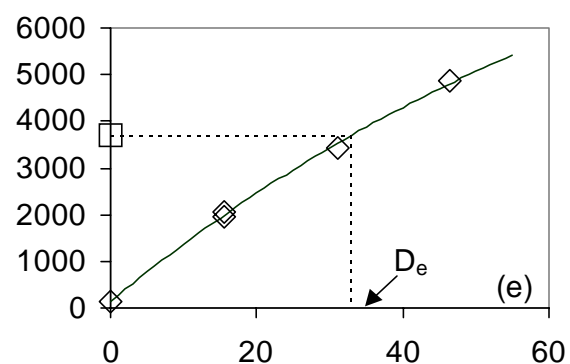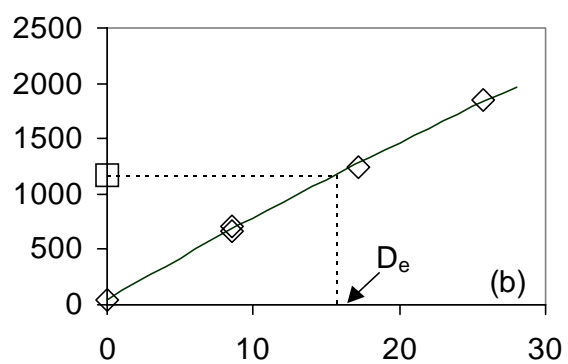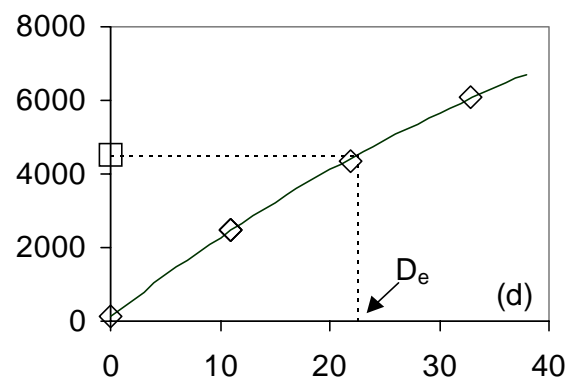
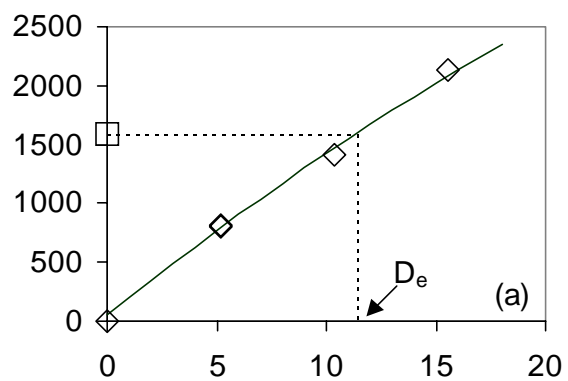## REFERENCES CITED

Adamiec, G. and Aitken, M., 1998, Dose-rate conversion factors: update: Ancient TL, v. 16, p. 37-50.

Aitken, M.J., 1998, An introduction to optical dating. Oxford University Press.

Bortolot, V.J., 1997, Improved OSL excitation with fiberoptics and focused lamps: Radiation Measurements, v. 27, p. 101-106.

Clarke, M.L., Rendell, H.M. and Wintle, A.G., 1999, Quality assurance in luminescence dating: Geomorphology, v. 29, p. 173-185.

Mejdahl, V., 1979, Thermoluminescence dating: beta attenuation in quartz grains. Archaeometry, v. 21, p. 61-73.

Murray, A.S. and Wintle, A.G., 2000, Luminescence dating of quartz using an improved single-aliquot regenerative-dose protocol: Radiation Measurements, v. 32, p. 57-73.

Prescott, J.R. and Hutton, J.T., 1994, Cosmic ray contributions to dose rates for luminescence and ESR dating: large depths and long-term time variations: Radiation Measurements, v. 23, p. 497-500.

Figure A. Examples of regenerated OSL growth curves from single aliquot regenerative-dose (SAR: Murray and Wintle, 2000) measurements on quartz extracted from sediment matrices. The square symbols represent the *natural* OSL intensity corresponding to build-up and storage of charge due to environmental radiation damage in the quartz since the sediment was deposited. The diamonds represent OSL signals that have been *regenerated*, effectively from zero, by administering subsequent artificial doses of radiation in the laboratory. The regenerated points are fitted with a single saturating exponential function. Interpolation of the natural OSL level with the regenerated data (dotted lines) indicates the equivalent dose (D_e) of radiation in Gy. Several such measurements are made on each sample and the mean D_e value is divided by the annual environmental dose-rate ($mGya^{-1}$) to give the age of the sample. See Table A and text for further details. (a) OVF2-8; (b) OVF2-5; (c) OVF2-9; (d) OVF2-7; (e) OVF2-6.

Sensitivity corrected net OSL

Regenerative dose (Gy)