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OSL dating methods

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Optical dating

The light-sensitive nature of quartz optically-simulated luminescence (OSL) (Spooner 1994) makes quartz a valued environmental dosimeter for the optical dating of unburnt sediment, where the resetting mechanism was exposure to sunlight. Age evaluation by the optical dating technique requires both measurement and calibration of the OSL that has accrued since the last exposure to light, termed the palaeodose, (P), and also of the environmental dose-rate; these are further discussed by Aitken (1998).

Sample collection and preparation and palaeodose (P) measurement

Sediment samples were collected using steel coring tubes driven into freshly-exposed section faces, and each core tube contained sufficient sediment for *in-situ* water content measurement and for laboratory assay of the soil radioisotope (U, Th and K) concentrations.

In the laboratory, quartz grains of 90-125 μm were extracted from each sediment sample under low-intensity red and orange light (Spooner et al. 2000) in a procedure involving sequential HCl acid digestion, dry sieving, heavy liquid flotation (collecting < 2.68 g cm^{-3} fraction), and then etching in 48 % HF acid for 40 minutes to remove the outer 6-8 μm alpha-particle irradiated shell. OSL measurements were performed on approximately 5-6 mg of etched quartz attached by silicone oil to the central 7 mm diameter of each of 128 stainless steel discs.

OSL measurements were made using an Elsec Type 9010 automated reader with 500 ± 80 nm stimulation, and UV emissions detected by an EMI 9235QA photomultiplier tube optically filtered by one UG 11 and one U-340 filter and P determined by the "Australian slide" (Prescott et al., 1993) using a linear plus single saturating exponential fit (scale factor = 1.00). Two representative Australain Slide growth curves are shown in Figs 1 and 2. Further details may be found in Spooner et al. (2001).

Dose-rate determination

The U, Th and K concentrations in the bulk sediment were measured by neutron activation analysis and delayed neutron activation (NAA/DNA) (Becquerel Laboratories, Lucas Heights Science and Technology Centre), and K was calculated from measurements of K_2O by x-ray fluorescence (XRF) (Dept. Geology, ANU). Radioisotope activities for U, Th and K were also measured by high-resolution gamma spectrometry (CSIRO Division of Land and Water, Canberra, Australia) and subsequently converted to concentrations; these data confirmed secular equilibrium in the U and Th decay chains. As *in situ* gamma-ray scintillometry was unavailable, the samples were collected greater than 30 cm from unit boundaries hence it is assumed that laboratory radioisotope assays are valid for gamma dose-rate calculation. The best estimates of the bulk sediment concentrations of U, Th and K were calculated by weighted means of the measured values.

Cosmic ray dose-rates were calculated using the data of Prescott and Hutton (1994), making allowance for site altitude, geomagnetic latitude and time-averaged thickness of sediment overburden (estimated by JWM). Alpha-particle irradiation from radioisotopes within the etched quartz grains was assumed to be 10% of the external

activity (Aitken, 1998), and the efficiency with which alpha-particle irradiation induced OSL was assumed to be a = 0.05 ± 0.02, following Questiaux (1990) and Thorne et al. (1999).
Long-term water content was estimated from measured values and reconstructions of the landscape history and topographic position by JWM with adopted uncertainties sufficient to accommodate all likely possibilities. Table 1 presents the palaeodose measurements, the dose-rates, water content estimates and ages calculated using the AGE program of Grün (1999), incorporating the dose-rate conversion factors of Adamiec and Aitken (1998).

Table Caption

Table 1. OSL ages for each sample, along with the measured palaeodose, calculated dose-rates and estimated water contents.

Figure Captions:

Fig 1. Australian Slide growth curve for sample WmPt7

Fig 2. Australian Slide growth curve for sample Syd Harb 2

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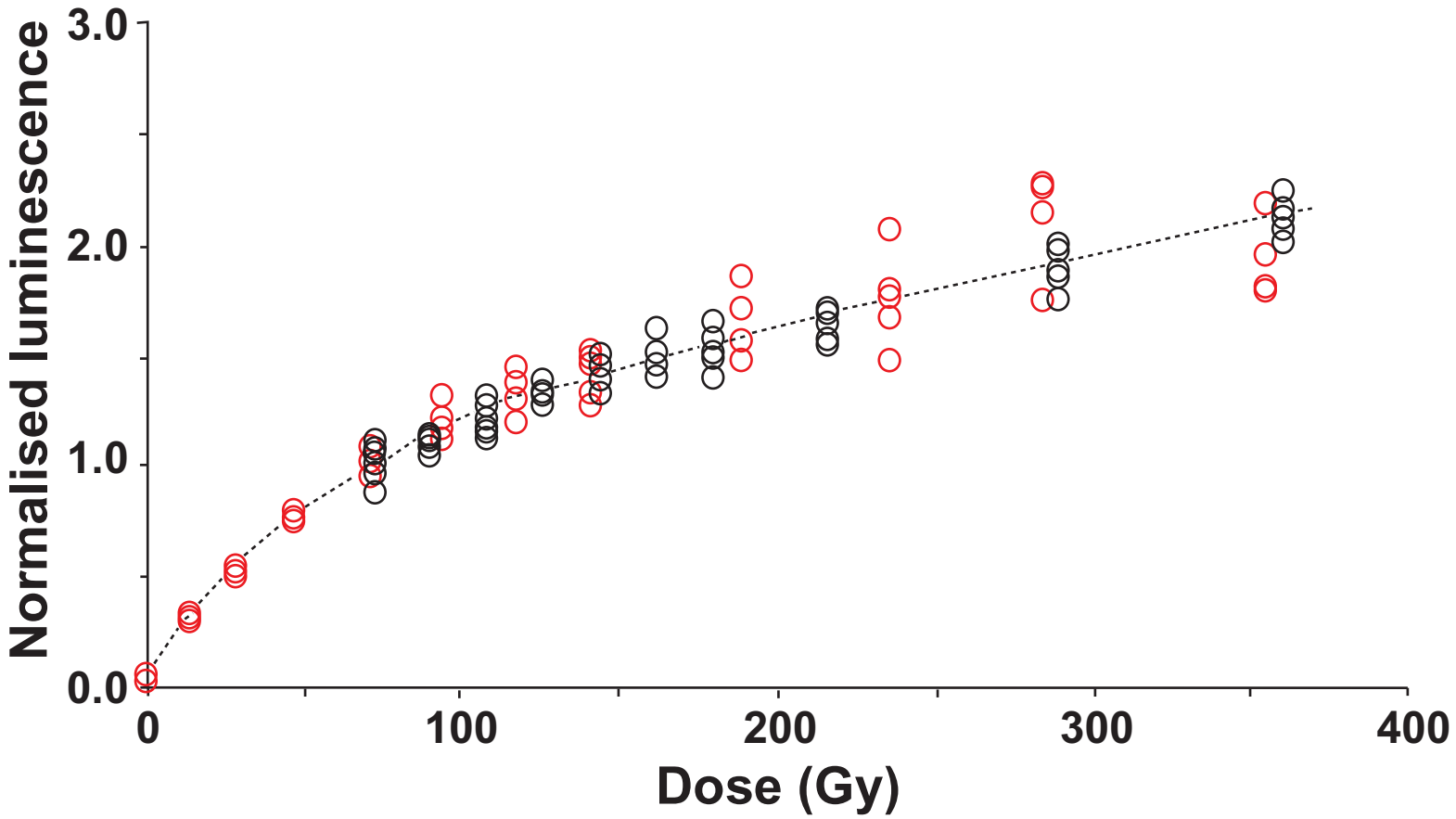
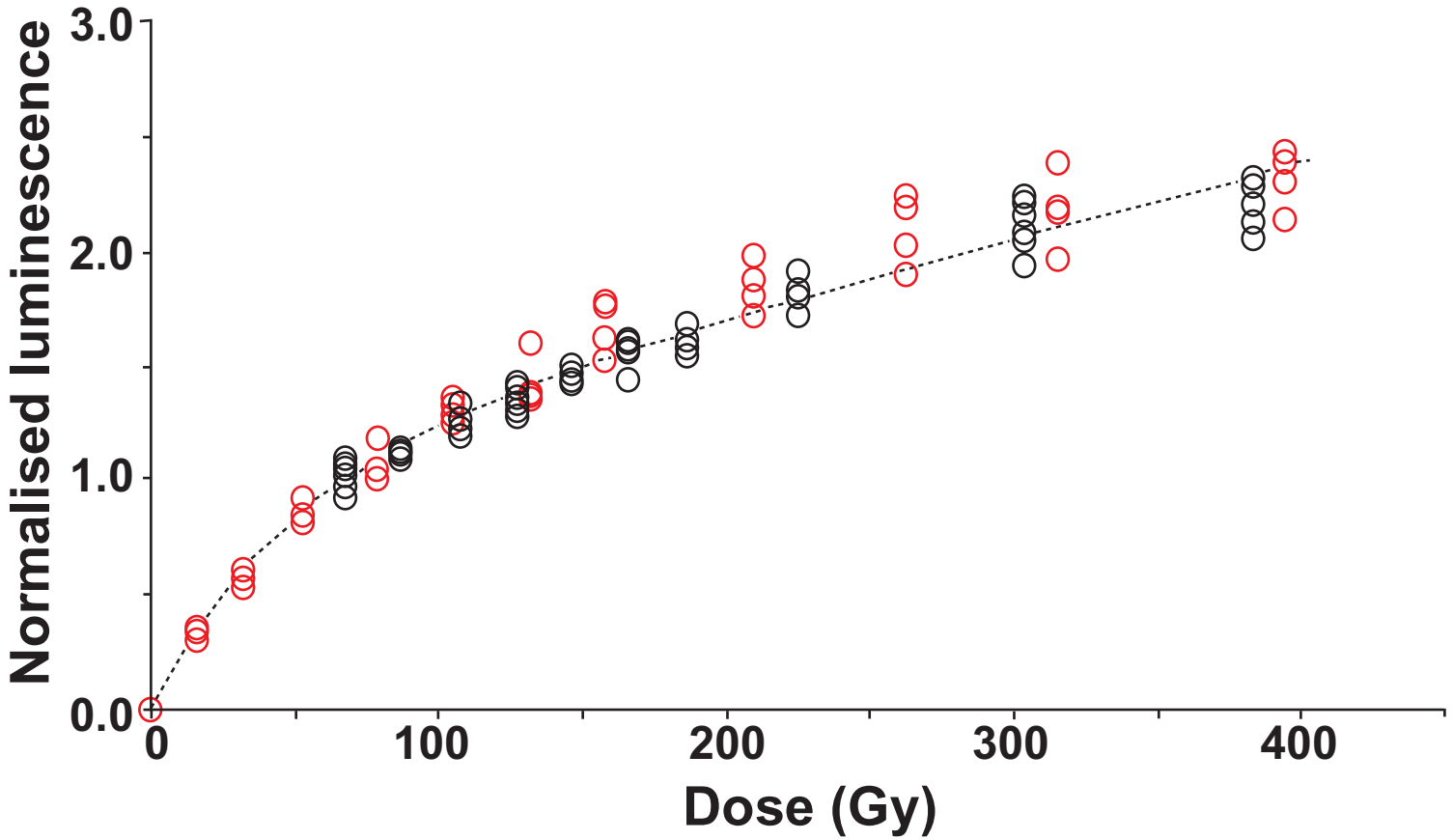
Table 1. OSL ages for each sample, along with the measured palaeodose, calculated dose-rates and estimated water contents.

	Field Sample number	Lab code number	Paleodose (Gy)	Dose rate (Gy/ka)	Percent water	Age (ka)
1	KWB 4	$ANU_{OD}1063$	64.7 ± 3.4	0.67 ± 0.03	15.0 ± 3.0	109.9 ± 7.6
2	KWB 6	$ANU_{OD}1064$	55.0 ± 2.1	0.59 ± 0.02	12.0 ± 2.4	102.7 ± 5.4
3	KWB 9	$ANU_{OD}1065$	77.0 ± 2.1	0.85 ± 0.02	9.0 ± 2.3	99.7 ± 4.4
4	KWB 10	$ANU_{OD}1066$	56.9 ± 2.8	1.03 ± 0.02	15.0 ± 2.3	62.8 ± 3.6
5	KWB 11	$ANU_{OD}1067$	63.6 ± 1.9	1.36 ± 0.02	12.0 ± 2.4	52.0 ± 2.1
6	KWB 13	$ANU_{OD}1068$	29.8 ± 0.6	1.01 ± 0.02	9.0 ± 3.9	31.5 ± 1.4
7	WmPt 6	$ANU_{OD}1076$	99.4 ± 2.9	1.20 ± 0.03	6.0 ± 1.5	88.1 ± 3.8
8	WmPt 7	$ANU_{OD}1077$	78.4 ± 2.7	1.28 ± 0.03	6.0 ± 1.5	63.1 ± 2.8
9	WmPt 10	$ANU_{OD}1078$	98.7 ± 4.6	1.22 ± 0.02	12.0 ± 2.4	88.5 ± 4.9
10	WmPt 11	$ANU_{OD}1079$	69.1 ± 1.8	1.37 ± 0.03	9.0 ± 2.3	50.4 ± 1.8
11	WmPt 13	$ANU_{OD}1080$	55.9 ± 3.0	1.18 ± 0.03	9.0 ± 2.7	50.8 ± 3.3
12	Punkra 2	$ANU_{OD}1072$	52.2 ± 2.4	0.73 ± 0.03	9.0 ± 1.8	78.6 ± 4.9
13	Punkra 6	$ANU_{OD}1073$	91.7 ± 5.9	0.96 ± 0.03	6.0 ± 1.5	100.1 ± 7.2
14	Punkra 8	$ANU_{OD}1074$	174.3 ± 6.4	1.32 ± 0.03	6.0 ± 1.5	137.3 ± 6.5
15	Dul 1	$ANU_{OD}1086$	25.0 ± 1.1	0.74 ± 0.03	10.0 ± 2.5	36.4 ± 2.3
16	TBM 92/1 1	$ANU_{OD}1081$	55.1 ± 1.5	0.75 ± 0.03	9.0 ± 2.3	77.1 ± 3.8
17	TBM 92/1 2	$ANU_{OD}1082$	46.0 ± 3.9	0.61 ± 0.03	9.0 ± 2.3	78.4 ± 7.6
18	WW 2	$ANU_{OD}1070$	90.3 ± 3.4	1.01 ± 0.02	9.0 ± 2.3	96.6 ± 4.7
19	L Out 1	$ANU_{OD}1075$	98.5 ± 4.4	1.79 ± 0.06	12.0 ± 2.4	62.3 ± 3.8
20	Lake Dom 1	$ANU_{OD}1047$	140.9 ± 6.2	1.382 ± 0.042	10.0 ± 2.5	110.2 ± 6.3
21	Lake Dom 6	$ANU_{OD}1049$	62.6 ± 1.7	1.227 ± 0.038	9.0 ± 2.7	51.0 ± 2.1
22	Lake Dom 9	$ANU_{OD}1051$	32.3 ± 1.5	0.493 ± 0.025	8.0 ± 2.4	69.2 ± 4.9
23	M95 TL 1	$ANU_{OD}1104$	110.7 ± 4.8	0.861 ± 0.033	9.0 ± 2.7	124.9 ± 7.4
24	M95 TL 3	$ANU_{OD}1106$	106.7 ± 4.7	0.931 ± 0.031	10.0 ± 3.0	119.9 ± 7.2
25	M95 TL 5	$ANU_{OD}1107$	21.6 ± 0.8	0.699 ± 0.026	9.0 ± 2.7	32.4 ± 1.8
26	Syd Harb 1	$ANU_{OD}1098$	84.9 ± 4.6	0.798 ± 0.024	12.0 ± 3.0	118.9 ± 7.9
27	Syd Harb 2	$ANU_{OD}1099$	67.6 ± 2.1	0.959 ± 0.033	8.0 ± 2.4	73.5 ± 3.7
28	Camel Sw 1	$ANU_{OD}1403$	68.6 ± 2.2	1.069 ± 0.037	9.0 ± 1.4	64.2 ± 3.0
29	Camel Sw 2	$ANU_{OD}1404$	73.4 ± 2.0	1.146 ± 0.041	6.0 ± 1.0	64.1 ± 2.9
30	L Mary B	$ANU_{OD}1401$	62.8 ± 3.7	0.808 ± 0.03	3.9 ± 0.6	77.7 ± 5.4


Normalised luminescence
3.0
2.0
1.0
0.0
0
100
200
300
400
Dose (Gy)


Normalised luminescence
3.0
2.0
1.0
0.0
0
100
200
300
400
Dose (Gy)