Comparison of paired quartz OSL and feldspar post-IR IRSL dose distributions in poorly bleached fluvial sediments from South Africa

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Published in:
Quaternary Geochronology

DOI:
10.1016/j.quageo.2015.02.015

Publication date:
2015

Citation for published version (APA):
Colarossi, D., Duller, G. A. T., Roberts, H. M., Tooth, S., & Lyons, J. R. (2015). Comparison of paired quartz OSL and feldspar post-IR IRSL dose distributions in poorly bleached fluvial sediments from South Africa. *Quaternary Geochronology*, *30*(B), 233-238. https://doi.org/10.1016/j.quageo.2015.02.015

Supplementary information

Measurement parameters for quartz ages

Establishing a suitable preheat temperature for use in the single aliquot regenerative dose (SAR) protocol is necessary to avoid the potential for thermal transfer of the luminescence signal and to ensure that luminescence signals generated by laboratory irradiation can be compared with those arising from irradiation in nature over long periods of time (Wintle and Murray, 2006). A preheat plateau test using natural signals is not appropriate for samples affected by partial bleaching because the variability in the natural D_e values may obscure changes in the D_e resulting from preheat conditions (Jain *et al.*, 2004). In this situation, it is preferable to determine suitable preheat conditions by recovering a laboratory dose at various different preheat temperatures. Thus, dose recovery was assessed using preheat temperatures between 140 °C and 280 °C at 20 °C intervals after first removing the natural signal from 24 medium aliquots. The natural signal was removed using two separate stimulations with the blue LEDs at 80 % power for 1 ks at room temperature, separated by a pause of 10 ks (2.8 hr) to allow the charge in the 110 °C trap to empty. A known beta dose, similar to the expected natural D_e, was administered to the aliquots. The ratio of measured to given dose was within 5 % of unity over the preheat temperature range of 200 – 260 °C. Based on these experiments a preheat of 260 °C for 10 s was selected (Lyons, 2012). The test dose preheat temperature was 160 °C with immediate cooling. OSL measurements were made at 125 °C to prevent re-trapping of charge. A minimum of four regeneration points were measured for each aliquot and used to construct the dose response curve.

OSL decay curves display rapid reduction in the luminescence signal with optical stimulation. The rapidly bleachable properties are consistent with dominance of the fast component. D_e values were determined by integrating the initial 0.8 s of the decay curve, minus a late background taken from the last 8 s of the decay curve. The IR-OSL depletion ratio (Duller, 2003) was used to test for feldspar contamination; ratios were within 10 % of unity which is considered to be within acceptable limits.

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Table S1: Outline of the single aliquot protocols used for a) quartz OSL and b) feldspar post-IR IRSL measurements

	a) Quartz OSL		b) Feldspar post-IR IRSL	
Step	Treatment	Measured	Treatment	Measured
1	Dose	-	Dose	-
2	Preheat (260 ˚C for 10 s)	-	Preheat (250-320 ˚C for 60 s)	-
3	OSL (125 ˚C for 40 s)	Lx	IRSL (50 ˚C for 200 s)	-
4	Test dose (~4 Gy)	-	IRSL (225-290 ˚C for 200 s)	Lx
5	Preheat (160 ˚C for 0 s)	-	Test dose (~5 Gy)	-
6	OSL (125 ˚C for 40 s)	Tx	Preheat (250-320 ˚C for 60 s)	-
7	Return to step 1		IRSL (50 ˚C for 200 s)	-
8			IRSL (225-290 ˚C for 200 s)	Tx
9			IRSL (290-325 ˚C for 100 s)	-
10			Return to step 1	

Table S2: Dose rate data for samples collected from the unnamed tributary of the Moopetsi River.

Sample	Potassium concentration (%)	Uranium concentration (ppm)	Thorium concentration (ppm)	Cosmic dose rate (Gy/ka) [1]	Quartz total attenuated dose rate (Gy/ka)[2]	Feldspar total attenuated dose rate (Gy/ka)[2]
MPT8	1.08 ± 0.08	1.67 ± 0.27	7.50 ± 0.88	0.20 ± 0.02	1.84 ± 0.09	2.65 ± 0.11
MPT12	2.08 ± 0.09	1.49 ± 0.16	3.82 ± 0.51	0.20 ± 0.02	2.37 ± 0.10	3.15 ± 0.12
MPT13	1.88 ± 0.09	1.49 ± 0.17	4.47 ± 0.56	0.15 ± 0.02	2.20 ± 0.10	2.98 ± 0.12
MPT14	1.24 ± 0.06	1.34 ± 0.15	3.83 ± 0.49	0.13 ± 0.01	1.61 ± 0.07	2.37 ± 0.10
MPT3	1.30 ± 0.07	1.21 ± 0.16	4.34 ± 0.51	0.15 ± 0.02	1.69 ± 0.08	2.45 ± 0.10
MPT4	2.16 ± 0.09	0.82 ± 0.15	4.20 ± 0.48	0.13 ± 0.01	2.25 ± 0.10	3.01 ± 0.12
MPT10	1.70 ± 0.08	1.68 ± 0.14	3.43 ± 0.47	0.14 ± 0.01	2.03 ± 0.09	2.80 ± 0.11
MPT9	1.20 ± 0.06	0.89 ± 0.13	4.04 ± 0.42	0.11 ± 0.01	1.49 ± 0.07	2.23 ± 0.09
MPT6	1.60 ± 0.07	0.63 ± 0.16	4.84 ± 0.51	0.09 ± 0.01	1.77 ± 0.08	2.53 ± 0.10
MPT7	1.31 ± 0.06	0.77 ± 0.10	2.69 ± 0.32	0.09 ± 0.01	1.44 ± 0.06	2.17 ± 0.09

[1]Cosmic dose rate calculated according to Prescott and Hutton (1994).
[2]For each mineral the total dose rate to the sample has been adjusted to correct for attenuation due to grain size and water content. The mean water content over the depositional history of the sediments was estimated to be 15 ± 5 % expressed as weight of water/weight of dry sediment.

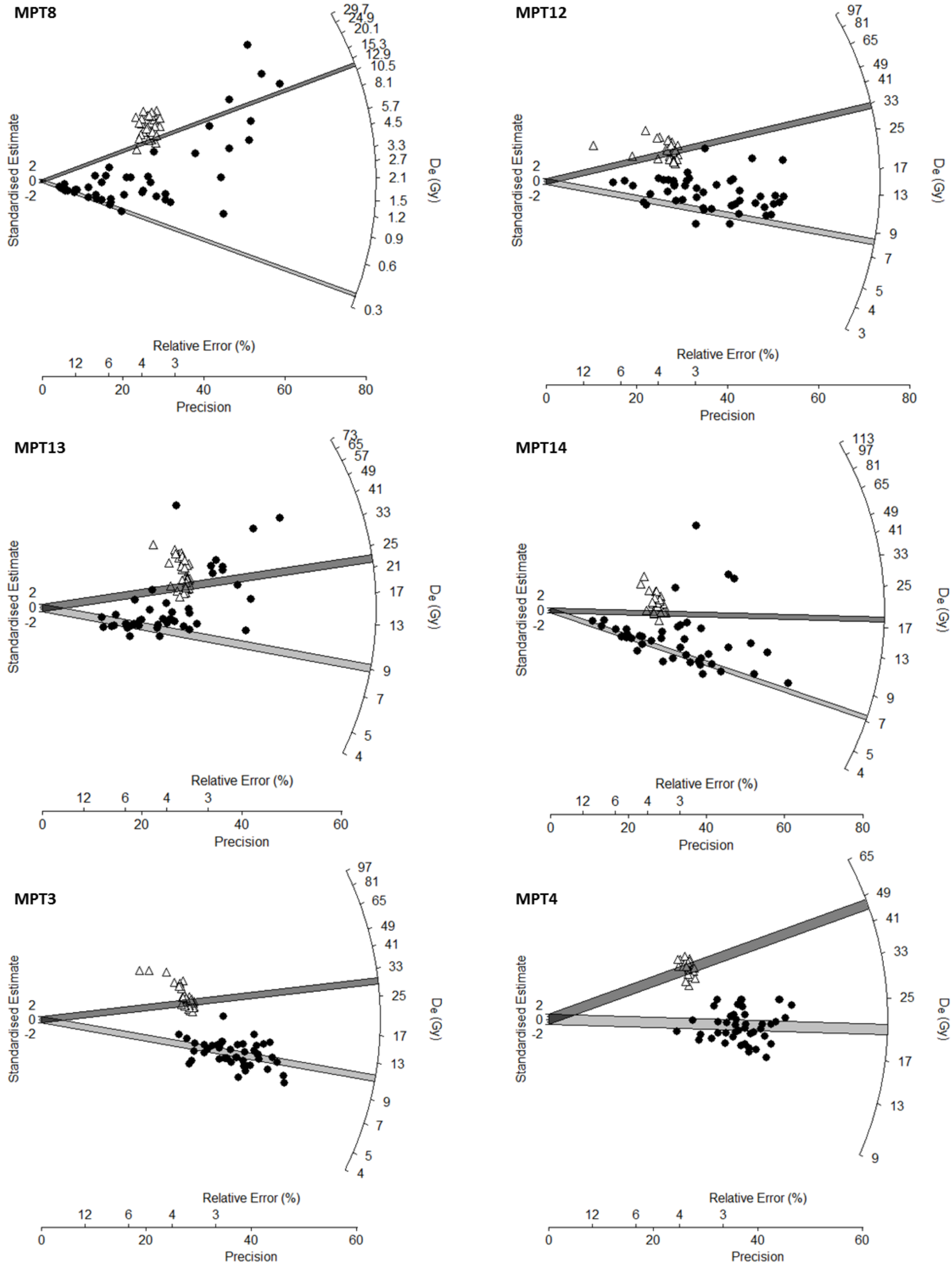

Figure S1: D_e distributions from quartz OSL (filled circles) and feldspar post-IR $IRSL_{225}$ (open triangles) signals. Shaded regions represent D_e values used for age calculation, determined either using the CAM or the MAM. See Table 1 for details.

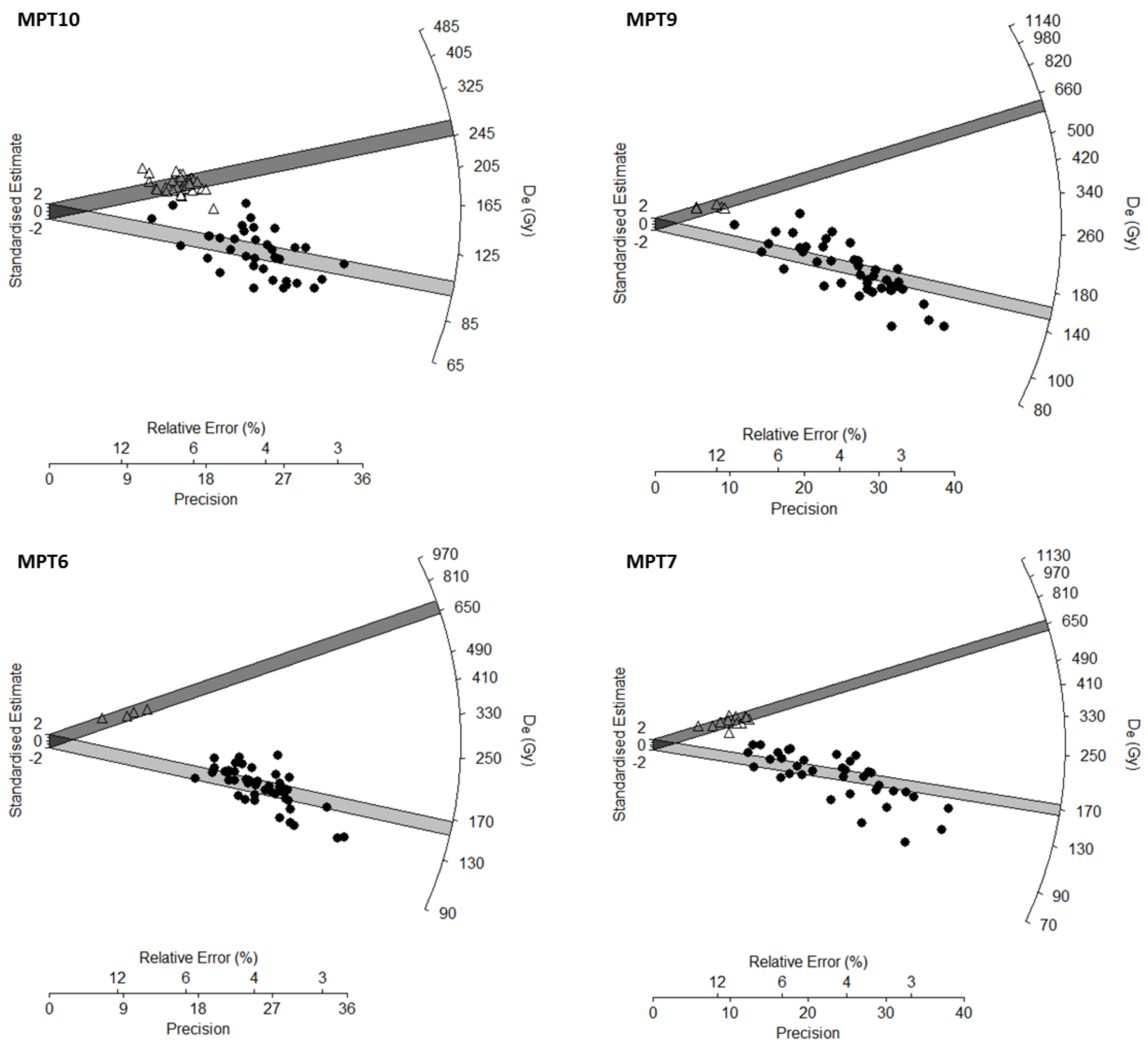

Figure S1 (continued): D_e distributions from quartz OSL (filled circles) and feldspar post-IR $IRSL_{225}$ (open triangles) signals. Shaded regions represent D_e values used for age calculation, determined either using the CAM or the MAM. See Table 1 for details.