Supplementary Data

OSL and radionuclide methods

Optical dating samples were extracted from stainless steel, light-proofed auger heads, wrapped, and returned to Griffith University for analysis. Sample preparation was designed to isolate pure extracts of 180-212 µm light safe quartz grains following standard procedures (e.g. Aitken, 1998). Treatments were applied to remove contaminant carbonates, feldspars, organics, heavy minerals and acid soluble fluorides. The outer ~10 µm alpha-irradiated rind of each grain was removed by etching in 48 % hydrofluoric acid. A burial dose was determined from measurement of the OSL signal emitted by single grains of quartz. The etched quartz grains were loaded on to custom-made aluminium discs drilled with a 10 x 10 array of chambers, each of 300 µm depth and 300 µm diameter (Botter-Jensen et al. 2000). The OSL measurements were made on a Risø TL/OSL DA-20 reader using a green (532 nm) laser for optical stimulation, and the ultraviolet emissions were detected by an Electron Tubes Ltd. 9235QA photomultiplier tube fitted with 7.5 mm of Hoya U-340 filter. Laboratory irradiations were conducted using a calibrated 90Sr/90Y beta source mounted on the reader.

Equivalent doses (De) were determined using a modified SAR protocol (Olley et al., 2004). A dose-response curve was constructed for each grain. OSL signals were measured for 1 s at 125 °C (laser at 90% power), using a preheat of 240 °C (held for 10 s) for the 'natural' and regenerative doses, and a pre-heat of 160 °C (held for 10 s) for the test doses (5 Gy). The OSL signal was determined from the initial 0.1 s of data, using the final 0.2 s to estimate the background count rate. Each disc was exposed to infrared (IR) radiation for 40 s at 125 °C prior to measurement of the OSL signal to bleach any IR-sensitive signal. Dose recovery tests were also undertaken to confirm that this treatment did not diminish the OSL signal from quartz. Grains were rejected if they did not produce a measurable OSL signal in response to the 5 Gy test dose, had OSL decay curves that did not reach background after 1 s of laser stimulation, produced natural OSL signals that did not intercept the regenerated dose-response curves, or had unacceptable sensitivity changes throughout the measurement cycle i.e. they were rejected if either of the second or third Test Dose signals varied in sensitivity from the first Test Dose (associated with the Natural Dose) by more than 20 %. Lithogenic radionuclide activity concentrations of material extracted from sampling tubes were determined using high-resolution gamma spectrometry (Murray et al. 1987). Dose rates were calculated using the conversion factors of Stokes et al. (2003) with β-attenuation factors taken from Mejdahl (1979). Cosmic dose rates were calculated from Prescott and Hutton (1994). Burial doses were calculated using age modelling techniques of Galbraith and Laslett (1993) and Galbraith et al. (1999).

OSL and radionuclide results

Table S1 provides the results of radionuclide analysis along with the dose rates calculated using the relevant water contents and cosmogenic factors (latitude, longitude, altitude, time-averaged depth and density). In the Hunthawang samples, measured radionuclides suggest the decay chain is at or near secular equilibrium, within the bounds of the measured uncertainties. Viela samples GU32.2 and GU32.3 show evidence for disequilibrium between ^{238}U and ^{226}Ra. We tested the effect of this disequilibria on the calculated dose rate, first by assuming the decay chain down to ^{230}Th was in

secular equilibrium with uranium (radium loss or gain) and then assuming ^{230}Th and ^{226}Ra were in equilibrium (uranium loss or gain). The tests show that these assumptions have an unmeasurable effect on dose rates within the bounds of the calculated uncertainties, and hence no effect on the calculated ages. Measured water contents ranged from 7-13% for the floodplain and terraces and was 25% for the in-channel bench, but water contents may have been affected by seasonal factors, and drying during transport and collection. The long-term water content for these samples is estimated to have been around 7±2.5%, and this estimate was used for all samples. Table S2 gives details of the overdispersion, recovery and modelled equivalent doses using the Central Age Model (CAM) and Minimum Age Model (MAM). Radial plots for all samples are shown in Fig. S1.

Recovery, i.e. the proportion of grains that yielded an acceptable luminescence signal, ranged from 7 to 36% in the palaeochannel samples. The lower recovery of 5% in underlying basement weathered sand at Viela (GU32.2) excludes a large number of saturated grains, and the result reported is a minimum age. Overdispersion (σ_d) i.e. the degree of spread in the data beyond that which can be explained by measurement uncertainties, was between 17 and 39 %, which is typical of fluvial samples. The choice of age model is difficult in overdispersed samples, and high values of σ_d may be owing to the confounding effects of bioturbation, incomplete or partial bleaching, high dose rate heterogeneity or other unidentified unreliability of grains as dosimeters. Fluvial sediments are typically poorly bleached during transport and deposition, hence, as a first step, a three parameter Minimum Age Model (MAM) was used to calculate the depositional age for all samples. Where partial bleaching is not the primary reason for overdispersion, then use of the minimum age model is inappropriate. Stratigraphic and sedimentological considerations suggest that the high overdispersion values calculated for GU4.7 and GU32.2 are owing to factor(s) other than partial bleaching. Accordingly, we have calculated the age for these two samples using a D_e determined using the CAM.

[Figure S1. Radial plots for all OSL samples.]

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Table S1 – Activity concentrations of selected radionuclides and environmental dose rates

Sample	^{238}U Bq/kg	^{226}Ra Bq/kg	^{210}Pb Bq/kg	^{232}Th Bq/kg	^{40}K Bq/kg	Dose Rate Gy/ka
Hunthawng – Terrace edge						
GU4.7	39±4	43±1	34±4	58±2.1	534±8	3.4±0.2
Hunthawang - Scroll plain						
GU4.13	32±3	29.7±1.0	31±3	46±2	429±7	2.8±2.0
GU4.8	40±3	39±1	52±4	53±2	481±7	3.4±0.2
GU4.9	23.2±3.2	27.7±0.6	27.3±3.1	36±1	418±6	2.5±0.2
Hunthawang - Floodplain						
GU4.10	28.2±2.5	29.1±0.4	31±2	43±2	373±4	2.5±0.2
GU4.11	34±3	34.0±0.5	45±3	48±1	512±6	3.3±0.2
GU4.12	24.1±3.3	22.3±0.5	27.0±2.9	33±2	474±7	2.6±0.2
Hunthawang - In-channel bench						
GU4.14	24.3±3.1	21.6±0.5	23.4±2.9	35±1	379±6	2.4±0.1
Viela – basement sediments						
GU32.2	33.9±1.9	41.9±0.9	42.0±2.3	42.8±0.5	380±3	2.7±0.2
Viela – scroll plain						
GU32.3	41.9±1.5	26.7±0.5	25.5±1.6	44.0±3.0	411±4	2.7±0.2
GU32.4	28.7±2.1	29.0±0.6	29.9±2.4	46.0±3.0	410±6	2.7±0.2

Table S2 – OSL results

Lab No.	n	Recovery (%)	σ_d (%)	D_e(CAM) (Gy)	D_e (MAM) (Gy)	Age (ka)
Hunthawang – terrace edge						
GU4.7	155	31	35	67±2	44±2	19.9±1.5#
Hunthawang - scroll plain						
GU4.13	43	9	22	50.0±1.9	45±4	16.2±1.9*
GU4.8	63	13	22	49.4±1.5	44±4	13.1±1.5*
GU4.9	46	9	32	55±3	46.9±1.8	18.8±1.4*
Hunthawang - floodplain						
GU4.10	47	9	17	22.3±0.6	20.9±1.4	8.3±0.8*
GU4.11	47	9	31	18.1±0.9	16.8±0.5	5.2±0.4*
GU4.12	77	15	39	17.2±0.8	14.4±0.4	5.5±0.4*
Hunthawang - in-channel bench						
GU4.14	37	7			0.11±0.01	0.05±0.01*
Viela– basement						
GU32.2	18	4	68	237±41	70±13	>87±16#
Viela – scroll plain						
GU32.3	98	20	36	65±3	43±3	16.2±1.6*
GU32.4	116	23	30	60±1.9	54.8±1.4	20.3±1.5*

*Minimum Age Model (MAM) #Central Age Model (CAM)