SUPPLEMENTARY MATERIAL

OSL – Methods and references

Samples for luminescence dating were prepared following standard procedures to extract 80-140 µm grains of both quartz and K-feldspar. OSL and post-IR IRSL at 290° C (pIRIR290) measurements were performed on multi-grain aliquots (several hundred grains were measured for each aliquot). Standard SAR protocols (see for quartz: Wintle and Murray 2000; for K-feldspar: Thiel et al. 2011; Buylaert et al. 2012) were implemented (see e.g. the protocols used in Guérin et al. 2015). Gamma and beta dose rates were determined from high resolution gamma spectrometry; the measured concentrations in radioelements were converted in dose rates using the factors from Guérin et al. (2011), modified for the effect of water after Guérin and Mercier (2012) and for the effect of grain size attenuation after Guérin et al. (2012). Cosmic dose rates were determined after Prescott and Hutton (1994) based on the thickness of sediment overburden.

For two samples (MK15/6 and MK15/8), an important disequilibrium in the U-series was observed, which might be linked with the above-mentioned level fluctuations in the water table and/or the presence of iron hydroxide precipitation. Without further information about the nature (leaching of ^{238}U or uptake of ^{226}Ra) and timing of the disequilibrium (Guibert et al., 2009), the ages presented in this study were calculated assuming a linear uptake model, which seems to be the most parsimonious hypothesis and corresponds to a midway scenario (and set of ages). It should be noted here that humidity of the sediment was determined from measurements at sampling time; this present-day moisture content was considered to be representative of that during burial (except for sample MK16/2: the measured water content was 5±2%, which seems a bit low compared to other values; arbitrarily, we used 10±5%. Ongoing work should in the future allow refining the water concentrations for all sediment samples).

Quartz OSL and K-feldspar post-IR IRSL ages are in agreement for all samples (with a slight overestimation of K-feldspar compared to quartz, which is common since the resetting of K-feldspar post-IR IRSL signals is much slower than that of quartz OSL) but four (the two oldest samples, MK15/8 and MK15/7 as well as MK16/2 and MK16/3 which are belong to eastern section). For the four latter samples, assuming that quartz OSL was totally reset before sediment deposition, the residual doses for the K-feldspar post-IR IRSL correspond to 49 Gy ,74 Gy, 54 Gy and 282Gy for samples MK15/8 ,MK15/7, MK16/2 and MK16/3, respectively. These relatively high residual doses(especially for MK16/3), in comparison with commonly reported values of ~5-20 Gy for well bleached samples (e.g., Buylaert et al. 2012) indicate that light exposure of the sediment prior to burial was insufficient to completely reset the K-feldspar post-IR IRSL signal. This observation might be the result of the above-mentioned shallow water deposition during flood events. In any case, the K-feldspar post-IR IRSL ages should be regarded as maximum ages. Nevertheless, such a poor bleaching of the K-feldspar signal does not necessarily imply that quartz OSL was not fully bleached (Murray et al. 2012) since the reset of quartz OSL during light exposure is several orders of magnitude faster than that of K-feldspar post-IR IRSL (Buylaert et al. 2012). In fact, Guérin et al. (2015) already observed such high residual doses (60-80 Gy) for K-feldspar post-IR IRSL signals from samples for which multi-grain quartz OSL was well-bleached, as indicated by the comparison with radiocarbon ages.

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