Supplementary 5

Results OSL-dating - Investigating the robustness of the minimum age approach

Rodnight (2008) regarded a minimum of 30 aliquots, if available, as beneficial for a MAM approach. She analyzed a sample with a low burial dose of ca. 2 Gy. In contrast to that the Datthausen samples produced D_es fitting not only in the lower steeply rising limb of the SAR dose response curve but also in the upper less steeply rising part. This means that there is a greater chance for aliquots with higher D_es being eliminated from the data set due to not meeting the quality criteria of having a relative D_e error of < 10 %. Further, based on an expected D_e of a sample, usually estimated by a test measurement of a few aliquots, for each dating measurement there is a maximum regeneration dose point defining the maximum acceptable D_e of an aliquot (here 152 Gy). This, too, leads to a systematically stronger elimination of D_es at the upper end of the D_e distribution. In the Datthausen sample set, the lowermost and oldest sample HDS-1660 is affected most strongly by these effects. Furthermore, the sample provided only 24 D_es, after eliminating three outliers at the lower end (cf. Fig. 8/main text). Therefore, we tried to test the robustness of the burial-dose extraction of the MAM approach for sample HDS-1660. This we did by including in the data set of 24 'good aliquots' (acceptable aliquots due to section 3.2.5; black circles in Fig. S-5.1) another 16 'bad aliquots' with D_e errors > 10 % as well as D_es being extrapolated beyond the highest regeneration dose point (white circles in Fig. S-5.1). For an alternative test, we excluded the two aliquots with an error > 10 % below the maximum regeneration dose point, like in the version used for the MAM age calculation, thus including only 14 'bad aliquots' (cf. Table 6/main text; Fig. S-5.1e-h *versus* Fig. S-5.1a-d). For three aliquots no D_e error could be calculated by the software program Analyst (Duller 2013). These we included with an assumed error of once 0 % (Fig. S-5.1a, c, e, g) and once 100 % of D_e (Fig. S-5.1b, d, f, h). We used both a high sigma b of 0.2 (Fig. S-5.1c, d, g, h) and a low sigma b of 1.35 (Fig. S-5.1a, b, e, f). The latter is the lowest value for which all calculations, including the one used for the MAM calculation (cf. Table 6/main text), could be performed by the software program R 'Luminescence' (for further results with sigma b of 0.1 and 0.15, basically supporting the results illustrated in Fig. S-5.1, cf. supplementary 6). We calculated the burial dose repeatedly using the MAM technique by successively eliminating one aliquot after the other, starting from the top, i.e. with the aliquot with the highest D_e (#40 in Fig. S-5.1a-d; #38 in Fig. S-5.1e-h), and continuing until ten aliquots were left. Center values and ranges of the extracted burial

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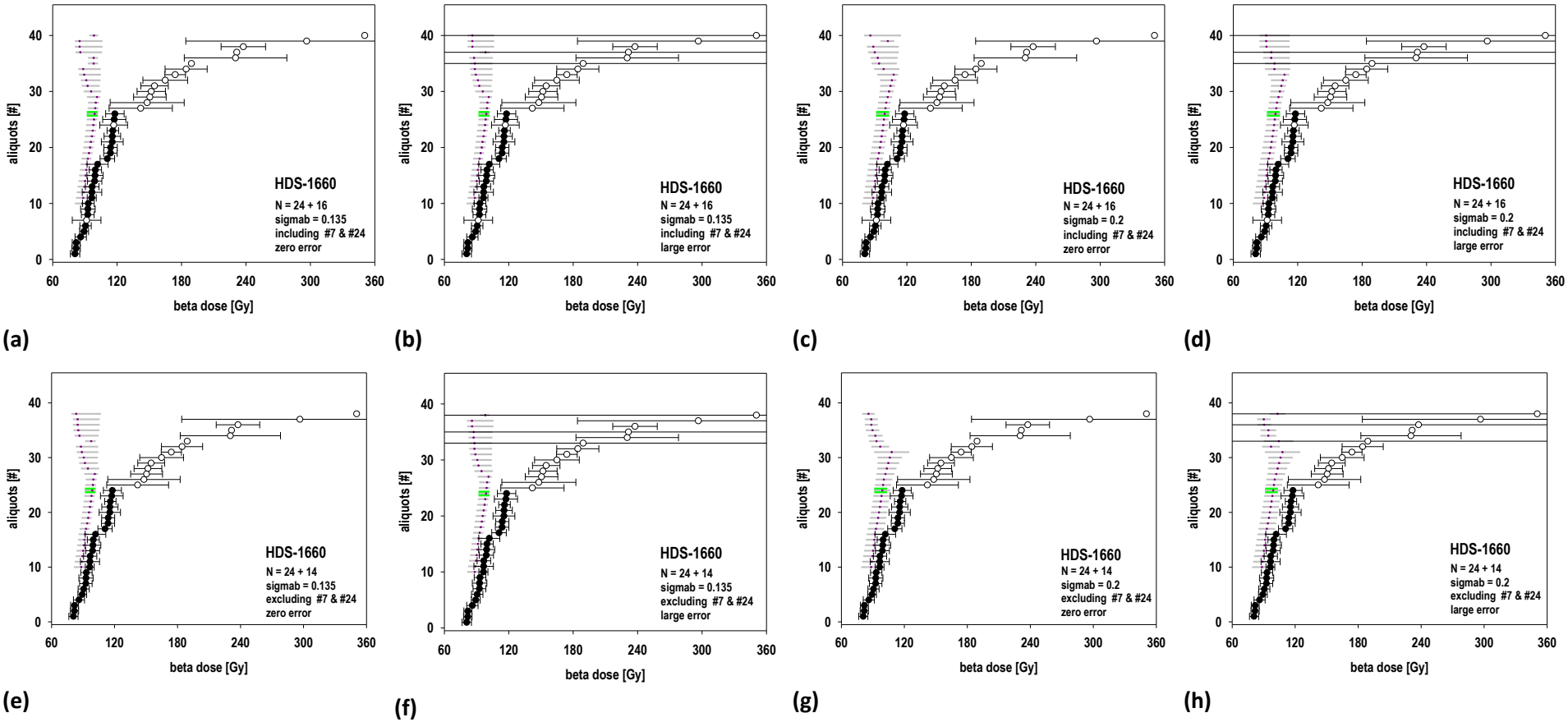


Fig. S-5.1. Extraction of the burial dose (D_b) applying the MAM approach (Galbraith et al., 1999) to sample HDS-1660 (only aliquots not belonging to FMM component 1 or 2; cf. Fig. 8). Black circles ('good aliquots'): aliquots meeting all quality criteria (cf. section 3.2.5). Circles with error bars: D_es of individual aliquots. White circles ('bad aliquots'): aliquots with maximum palaeodose error > 10 % and/or beyond highest SAR regeneration dose point (ca. 150 Gy). D_es < 150 Gy with palaeodose error > 10 % either included (**a - d**) or not included (**e – h**). D_es with non-calculable error either with assumed error 0 % (**a, c, e, g**) or 100 % (**b, d, f, h**). Horizontal grey bars with purple crosshair symbols: Range and center value of D_b extracted from population of aliquots arranged in upscaling order and successively reduced by one aliquot after another starting at the top (from 40 aliquots (**a – d**) or 38 aliquots (**e – h**) maximum down to ten aliquots minimum. Sigma b either 0.135 (**a, b, e, f**) or 0.2 (**c, d, g, h**). Horizontal green bar: Reference value from 24 aliquots meeting all quality criteria and as used for OSL age calculation (cf. Fig. 8).

doses are given as purple haircross symbols and grey horizontal bars in Fig. S-5.1. The burial dose extracted from the maximum of 24 'good aliquots' as used for MAM age calculation is represented in Fig. S-5.1 as a green horizontal bar (reference burial dose).

The center value of the extracted burial dose tends to increase with an increasing number of aliquots that are ordered in an upscaling direction (Fig. S-5.1). This shows that the resulting D_e may shift towards a lower value if higher D_es are systematically not included in the data set. However, including the relatively very high D_es, i.e. the 'bad aliquots' > ca. 150 Gy, does not change the burial dose significantly within error margins with respect to the reference value. Larger or lower relative errors of individual D_es (here 100 % versus 0 %) may have an effect on the center value and the errors of a burial dose (cf. Fig. S-5.1a *versus* b, range between aliquot #35 and #40). A stronger impact on the center value and the errors of a burial dose in the range of the upper 7 aliquots has the inclusion or exclusion of the two aliquots with a D_e < 150 Gy but a D_e error > 10 %. In the upper part the burial doses even show a tendency to jump back to lower values. Summing up, the burial dose used for the MAM-age calculation (green reference value) seems to give a good estimate for sample HDS-1660, which appeared to be the most problematic of the Datthausen data set with respect to a limited aliquot number and the systematic elimination of 'bad aliquots' at the upper end of the D_e distribution. However, for future studies it might be worthwhile to perform further analyses following those presented in the study by Rodnight (2008) and in the present study in order to gain a better understanding of the OSL-age modelling.

Reference

Duller, G. (2013): Luminescence Analyst, version 4.10, build 26 March 2013.

Galbraith, R.F., Roberts, R.G., Laslett, G.M., Yoshida, H., Olley, J.M., 1999. Optical dating of single grains of quartz from Jinmium rock shelter, northern Australia. Part I: experimental design and statistical models. Archaeometry 41, 339–364.

Rodnight, H., 2008. How many equivalent dose values are needed to obtain a reproducible distribution? Ancient TL, 26 (1), 3–9.