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Anomalous fading: a reply to the comment by Huntley on "Isochron measurements of naturally irradiated K-feldspar grains"

Abstract

We are pleased that Huntley (this issue) has put forward another explanation for the data that we obtained when we measured the equivalent doses (De) of potassium (K) feldspar grains of different diameters using their infrared stimulated luminescence (IRSL) signals (Li et al., 2007). We also measured the fading rates for the IRSL signals from grains of different size and concluded that the fading rates were independent of grain size. Huntley is concerned that the fading rates (g-values) that we obtained had relatively large errors and that these could have masked any minor differences in the g-values; a small systematic shift in g-value with grain size could result in the observed differences in the ages that we obtained from the De values. Based on his calculations, he suggested that a 0.3%/decade systematic difference in g-value with grain size could explain the age differences seen in our data.

Keywords

comment, grains, reply, irradiated, naturally, measurements, fading, k, huntley, anomalous, isochron, feldspar, CAS

Disciplines

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Anomalous fading: a reply to the comment by Huntley on "Isochron Measurements of Naturally Irradiated K-Feldspar Grains"

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We are pleased that Huntley (2008) has put forward another explanation for the data that we obtained when we measured the equivalent doses (D_e) of potassium (K) feldspar grains of different diameters using their infrared stimulated luminescence (IRSL) signals (Li et al. 2007). We also measured the fading rates for the IRSL signals from grains of different size and concluded that the fading rates were independent of grain size. Huntley is concerned that the fading rates (g-values) that we obtained had relatively large errors and that these could have masked any minor differences in the g-values; a small systematic shift in g-value with grain size could result in the observed differences in the ages that we obtained from the D_e values. Based on his calculations, he suggested that a 0.3%/decade systematic difference in g-value with grain size could explain the age differences seen in our data.

The g-values that we obtained were from measurements of 4 aliquots for each grain size, and thus a relatively large error (~±0.5%/decade) was inevitable. We have now conducted fading rate measurements using more aliquots from two samples WG3 and SY3. For sample WG3, a total of 16 and 15 aliquots were measured for the grain sizes of 90-125μm and 180-212 μm, respectively. Values of 3.4±0.1%/decade and 3.3±0.1%/decade were obtained for the two grain sizes, respectively. For sample SY3, 9 aliquots were measured for each of the grain sizes of 90-125 μm, 150-180 μm and 212-250 μm and values of 3.2±0.1%/decade, 3.2±0.1%/decade and 3.2±0.1%/decade were obtained for the three grain sizes, respectively. The statistical error was substantially reduced by making more measurements and the results confirmed that the fading rates are indistinguishable for the different grain sizes in the two samples. Again, we conclude that a systematic dependence of fading rate on grain size can be ruled out.

Huntley's explanation that grains with different fading rates are sorted in nature is unlikely from a geological point of view. The samples used in our study (Li et al. 2007) are from desert dunes in northeastern China. The sand-sized K-feldspar grains in each sample are derived from a variety of sources and have been mixed by the action of wind over many hundreds of thousands of years. The grain sizes, selected by dry sieving, are from 90 to 250 µm. Since there are hundreds grains in each aliquot, the IRSL signal from the aliquot is also derived from a mixture of K-feldspar grains from different sources. Hence, the fading rate measured for each grain size is the average of many grains from a large variety of sources. It is unlikely that any natural process will sort systematically the grains with different fading rate into different grain sizes, with lower fading rates being measured for the larger grains.

It is also difficult to explain why the ages calculated using the internal dose are different from those calculated using the external dose, and why the ages calculated from the internal dose are consistent with quartz OSL age for all samples investigated, despite them having different underestimation factors. We have compared the ages calculated from the internal dose with true ages (quartz OSL ages and geological ages) for 13 samples ranging in age from 2-150 ka. We found that the ages calculated from the internal dose are consistent with the quartz OSL ages for all the samples investigated, despite the fact that they have different underestimation factors (Li et al. in press).

Our conclusion that the dose related to the internal dose rate did not fade is an explanation of the overall effect (Li et al. 2007). However, this explanation does not require that "that anomalous fading occurs when the radiation dose to a feldspar grain is from beta particles originating outside the grain, but does not occur when the beta particles originate inside the grain" as stated by Huntley. We agree that this is not a likely explanation of the effect. Another explanation, such as an increase in the number of non-fading traps in K-feldspar grains being proportional to the internal dose, is possible and is being explored.

Huntley's analysis of our data is also problematic. He took the ratio of the apparent feldspar IRSL age to the quartz OSL age as the fading factor, and used it as the underestimation factor in the equations for our data. The underestimation factor f is defined as the ratio between the intercepts of lines F, $D_f(0)$ and Q, $D_q(0)$ (Li et al. 2007). If we take f=0.62 as obtained by Li et al. (2007) for sample WG3, at D=0.5 Gy/ka for a grain size of 90-125µm, the calculated D_e is 34.3 Gy, which is

7% smaller than the measured value of 36.8 Gy. At D=1 Gy/ka, it is 36.5 Gy, which is also significantly smaller (12%) than the measured value D_e= 41.5 Gy.

We conclude that the explanation given by Huntley is not supported by experimental data, and does not have geological grounds.

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