P.3-5: A case against subtracting a laboratory residual dose for feldspar single-grain luminescence dating

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Evaluating the degree of signal resetting is critical for luminescence dating of Holocene-aged deposits. This is particularly important for slow-to-bleach feldspar post-infrared infrared stimulated luminescence (pIRIR) signals which may not be completely zeroed in nature, even by full sunlight exposure. It is common practice to test the degree to which pIRIR signals can be zeroed through laboratory bleaching in a solar simulator providing high-intensity light exposure at rates of 5-6 times natural sunlight. Such tests quantify 'unbleachable' laboratory residual doses which may be subtracted from modeled equivalent doses for paleodose estimation. Yet, the mechanism yielding unbleachable residual doses is unclear. This phenomenon is hypothesized to link to retrapping of liberated charge spurred by the high-energy part of the light spectrum that exists in nature and may be enhanced in laboratory sources [1,2].

We conducted an experiment to test the degree of pIRIR-150 signal bleaching accomplished by laboratory versus natural-sunlight stimulation. The experiment was performed on a late-Holocene-aged (~1.2 ka) glaciofluvial sample of 180-250 µm feldspar sand (paleodose = 5.97 ± 1.41 Gy) from the Northern Patagonian Ice Field, Chile. Prior work determined a low-temperature single-grain feldspar (pIRIR-150) protocol showed negligible-to-no fading and, combined with a minimum age model, was optimal for dating these deposits. We exposed one fraction of the sample in a SOL2 simulator for 24 hours and exposed another fraction to natural sunlight conditions for 115 hours in a rural outdoor environment, free of artificial light and sheltered from wind, in Wisconsin, USA. These two conditions provide comparable bleaching opportunities yet under different intensities and likely somewhat different spectra. We then measured the remaining post-exposure doses of the two fractions using the pIRIR-150 single-grain protocol. Results showed that sunlight was more effective than the SOL2 in resetting the pIRIR-150 signal although neither method completely reset all grains. An arithmetic mean of the single-grain equivalent doses yielded values of 2.18 ± 0.10 Gy for the laboratory-bleached fraction and 1.71 ± 0.08 Gy for the sunlight-bleached fraction. Yet, some grains of both fractions were completely zeroed. The unlogged minimum age model returned values of 0.66 ± 0.10 Gy for the laboratory-bleached fraction and 0.10 ± 0.14 Gy for the sunlight-bleached fraction indicating that enough grains can be reset in nature to obtain an accurate paleodose without subtraction of a laboratory residual. In all, these results suggest that some feldspar grains may be predisposed to bleach more completely than others and high-intensity laboratory stimulation aiming to mimic sunlight is not a suitable substitute for determining the bleachability of grains under natural conditions. We infer that minimum age models applied to single-grain pIRIR datasets preferentially weight not only the grains that received the most sunlight exposure prior to deposition, but also those most readily reset. Based on our results, we strongly advise against subtracting laboratory residual doses from young heterogeneously bleached sediments.

Keywords Bleaching, Holocene, pIRIR, Residual dose, Solar simulator

References

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