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POTASSIUM FELDSPAR AS A NATURAL DOSIMETER IN SOUTH AMERICA: CHALLENGES, LIMITATIONS AND APPLICATIONS

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Introduction: Along with quartz, potassium feldspar (K-feldspar) is the main natural dosimeter used in trapped charge dating methods, usually by means of infrared stimulated luminescence (IRSL) and thermoluminescence (TL). Despite its suitability for restrospective dosimetry, it is not widely used, partly due to the inherent associated problems, such as variable residual doses or athermal signal loss (fading). Here, we present luminescence characteristics relevant for dosimetry from K-feldspar grains of different sedimentary environments from South America. The described luminescence properties include signal sensitivity, residual doses, thermal and athermal stability and characteristic doses of dose response curves. Problems encountered during natural dose assessment, and new luminescence applications are also discussed.

Material and method: Sediment samples collected from coastal and alluvial fan deposits from the Chilean coast and from fluvial deposits from the Amazon Basin (Purus River) were prepared by treatments with H_2O_2 and HCl to eliminate, respectively, organic matter and carbonates. K-feldspar grains were isolated by density separation and the concentrates were later attacked with HF 10% and HCl 10% to eliminate the alpha irradiated layer and potential fluoride precipitates.

K-feldspar aliquots were mounted on stainless steel discs for measuring equivalent doses in a Risø TL/OSL DA-20 reader. Equivalent doses were estimated following single-aliquot regenerative (SAR) dose protocols applied to IRSL and post-infrared infrared stimulated luminescence (pIRIR) signals. TL signals were measured from room temperature to 450 °C with a heating rate of 5 °C/s.

Results: For all analyzed samples, IRSL measured at 50 °C (IR50) and pIRIR signals measured at 290 °C (pIRIR290) and TL signals can be classified as high sensitive, as few grains (<100 per aliquot) can emit enough luminescence signal even for doses representative of younger sedimentary deposits (<10 Gy).

Residual doses measured using the pIRIR290 signals varied between the studied sedimentary environments and appear to be controlled by turbidity of the transport medium. Thus, modern coastal samples present low residual doses of less than 1 Gy while modern samples from the Purus River in the Amazon Basin present residual doses of up to 165 Gy.

Regarding signal stability, the IR50 signal presented variable athermal stabilities though always over 1.5 %/decade, which is considered unstable. The pIRIR290 signals were mostly stable, even with natural signals in saturation. Athermal stability analysis of TL signals show how it is eroded towards higher temperature when measured few days after dose administration. Isothermal storage experiments using TL signals show detectable signal variations even for small periods of storage time (< 1000 s) at relatively low temperatures of 50-100 °C, which make these signals useful for thermochronology studies.

Characteristic doses (D_0) obtained from dose response curves for the pIRIR290 signals varied from ~300 Gy to ~1000 Gy for the Chilean alluvial sample and Amazonian fluvial sample, respectively.

Conclusions: Though some luminescence properties vary between study areas, the dosimetric performance of K-feldspar grains vary within a relatively small range in terms of signal sensitivity and characteristic doses if compared to quartz optically stimulated luminescence (OSL). However, residual doses and athermal signal loss must be taken into account when using this mineral as natural dosimeter. Analysis of TL signal to relatively low temperature variations reveals its applicability beyond sediment dating, including geological processes such as subsidence and exhumation and surface exposure.