Limits to depletion of blue-green light stimulated luminescence in feldspars: implications for quartz dating

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Abstract

Feldspar contaminants in quartz aliquots, either as micro-inclusions or as remnant grains (due to inadequate etching) can affect the accuracy and precision of paleodose estimates based on blue-green light stimulated luminescence (BGSL). Such contamination could also alter the shape of the BGSL stimulation curve of otherwise pure quartz. In this study, the functional relationship between the infra-red stimulated luminescence (IRSL) and BGSL of feldspars, (1) at different preheats, and (2) with IR bleaching at different stimulation temperatures and durations, is examined. The results suggest two trap populations participate in the feldspar BGSL process. These are: (1) Type (A) trap populations that can be stimulated by both the infra-red and the blue-green light at $125^\circ C$ and, (2) Type (B) trap populations that respond only to blue-green-light stimulation at $125^\circ C$. However, infra-red stimulation at elevated temperature ($220^\circ C$) (ETIR) permits depletions of charges in Type (A) and Type (B) to the extent that the feldspar BGSL can be reduced by up to 97\% in 5 min.

These results offer prospects for (1) improved precision in paleodose estimates based on quartz; (2) BGSL dating of quartz in a polyminerallic fine grain samples; (3) age estimates based on both quartz and feldspars from the same aliquots, and (4) dating based on feldspar micro-inclusions. © 2001 Elsevier Science Ltd. All rights reserved.

1. Introduction

Multiple aliquot optical dating of quartz mineral separates from sediments is often beset with large experimental errors on account of significant variance in the luminescence output from identical aliquots (henceforth termed scatter; Jain et al., 1999). Such a scatter in conjunction with non-linear fitting algorithms result in large errors on palaeodose, thereby limiting the use of luminescence methods in high precision dating (Felix and Singhvi, 1997). Luminescence dating of quartz is attractive because of its resistance to weathering and the absence of athermal fading. Scatter in the blue-green stimulated luminescence (BGSL) output of identically dosed quartz aliquot can arise from (1) presence of feldspar micro-inclusions (Stokes, 1994) or feldspar grain remnants due to inadequate etching, (2) heterogeneous bleaching (e.g. Clarke, 1996; Huntley and Berger, 1995; Olley et al., 1998; Duller and Murray, 2000), and (3) heterogeneity in dosimetry (Murray and Roberts, 1997). Scatter in regeneration growth curves may suggest an inherent variability in the sample behaviour for example due to phase contamination (e.g. Stokes, 1994) or different dose-response of each aliquot. Studies on quartz mineral separates from aeolian and alluvial sediments from the Thar desert indicated that two significant causes of scatter were: (1) contamination by BGSL from feldspar micro-inclusions, and (ii) the inadequacy of the natural-normalization procedure (Jain and Singhvi, 1999).

An assessment of the magnitude of BGSL contribution from feldspars and its removal is important for quartz BGSL