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Out of the dark - inverse modelling to make sense of luminescence properties of soils

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Novel single-grain luminescence measurements of quartz and feldspar grains offer exciting ways forward to characterize rates and mechanisms of soil bioturbation. However, to fulfil this potential, the attribution problem must be solved – we must know which bioturbation mechanisms can lead to the observed outcome. Inverse modelling is a well-known solution for such problems. We present a new stochastic model of the evolution of grain properties such as apparent age and intrinsic brightness of quartz and feldspar grains in a bioturbated soil column. The model can rapidly simulate the depth profiles of these grain properties due to various bioturbation mechanisms over long periods of time. These can then be compared with the observed profiles. We illustrate the inverse model process for a case study site near Cordoba in Spain, where apparent ages and intrinsic brightness were determined for single quartz grains and single feldspar grains (with a 50 degree and a 175 degree protocol). Results indicate that several hypothesized bioturbation mechanisms can indeed be excluded by inverse modelling. The model can easily be extended to include hillslope processes.