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Luminescence sensitivity of German loess: indicators of source variability

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Loess – a homogeneous, predominantly silt-sized aeolian sediment – has long been recognised as a valuable terrestrial record of past environmental conditions. Loess deposits drape some 10% of the Earth's land surface, accumulating almost continuously in some regions. Most aeolian dust is thought not to travel far, often deriving from fine-grained material transported by rivers from glaciated regions. The provenance of loess sediment is inferred from the trajectories of atmospheric circulation systems and how these may have changed in intensity and influence over a region through time. The most frequently used techniques for correlating aeolian dust deposits with likely source areas, including bulk geochemistry, age distributions of detrital zircons, and Sr-Nd isotope ratios in clays, remain limited in the information they may provide about loess provenance. Since loess is dominated by silicate minerals – namely, quartz and feldspars – it is advantageous to explore their potential as indicators of source changes within loess-paleosol sequences (LPS). Increasingly, researchers have been exploring variations in the luminescence characteristics of sedimentary quartz and feldspar as possible provenance tools. Of a range of approaches so far applied, luminescence sensitivity is the quickest to measure and provides a means to rapidly assess potential changes in sediment source down LPS.

Luminescence sensitivity – the signal intensity per absorbed radiation dose – arises from the efficiency of charge traffic between traps and luminescence centres within a crystalline framework. In a sedimentary context, sensitivity is the product of interplay between source lithology and the history of the mineral in question. Consequently, shifts in sediment provenance may be observed through variations in luminescence sensitivity down LPS. Despite the presence of thick loess deposits across Europe, however, this approach has yet to be tested on this continent.

Here we undertake an empirical investigation of the luminescence sensitivity characteristics of quartz and feldspar from different grain-size fractions at the Schwalbenberg LPS in the German Rhine valley. The Schwalbenberg LPS has recently been shown to respond to variability in Atlantic-driven climate oscillations in fine detail; it follows, therefore, that changes in source will likely be

recorded in its sediments. We test the potential of luminescence sensitivity as an indicator of changes in sediment source through time, comparing samples from a 30 m core (REM3) spanning the last full glacial cycle, with samples of oxygen isotope stage (OIS) 3-2 age exposed within a c. 6 m profile on the southern margins of the deposit. The temporal overlap of the two localities during OIS3 enables comparison of luminescence characteristics with respect to possible provenance during that timeframe; we find an inverse relationship between quartz and feldspar sensitivity, as well as variability in sensitivity between different quartz grain sizes. There is some indication that feldspar sensitivity increases during periods of soil formation down the core. These observations may suggest source variability over millennial timescales.