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Un-mixing the effect of post-depositional tillage turbation on OSL age-depth data through measurements and numerical simulations

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Agricultural systems are subject to severe land degradation, because anthropogenic erosion processes, such as tillage erosion, substantially increase erosion rates compared to natural settings. Optically Stimulated Luminescence (OSL) dating is often used to measure the age of depositional layers to quantify rates of landscape change. OSL dating in agricultural systems is however challenging, because the deposits are reworked in the tillage layer even long after their moment of deposition. This post-depositional mixing resets the built-up luminescence signal, which causes an offset between the apparent OSL ages and the actual deposition ages.

In this study we illustrate the effect of post-depositional mixing on geochronological OSL age-depth data from northeastern Germany and we developed tools to un-mix depositional and post-depositional ages. We analyzed 32 OSL samples from five locations in a kettle hole to reconstruct spatial and temporal deposition patterns. We were able to correct our chronologies for post-depositional mixing by tillage by accounting for (pre-)historical plough regimes. Next to these empirical data, we also modified a Soil-Landscape Evolution Model called Loricca to numerically simulate the effect of post-depositional mixing on depositional ages. This combination of measurements and simulations enabled us to constrain the spatial and temporal effects of post-depositional mixing on OSL age-depth data more accurately. This is an important step towards getting a better grip on the dynamics of agricultural landscapes including the associated dates and rates.