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Measuring phases and rates of soil redistribution in an agrarian kettle hole by using OSL and Bayesian age modelling

Viktoria Vornehm (1), Tony Reimann (1), Marijn van der Meij (1,2), Jakob Wallinga (1), and Michael Sommer (2)

(1) Wageningen University, Soil Geography and Landscape, Environmental Sciences, Wageningen, Netherlands (tony.reimann@wur.nl), (2) Leibniz Centre for Agricultural Landscape Research (ZALF), Muencheberg, Germany

Long term soil erosion and soil redistribution on agricultural lands in young morainic lowland settings are yet poorly studied. First studies show colluviation rates to be variable in time, with high rates coinciding with intense agricultural use. The ideal place to study colluviation in a young morainic landscape is a kettle hole as it forms a closed catchment, i.e. the kettle hole functions as trap for colluvial deposits. Here we study the soil redistribution in an agrarian kettle hole (CarboZALF-D) in the vicinity of the town Prenzlau in NE Germany by mapping the distribution of colluvium, sampling two catenas and dating altogether 32 samples by optically stimulated luminescence (OSL) dating.

The OSL dating of colluvial sediments in a young morainic setting is challenging and requires attention being paid to poor bleaching and the use of appropriate data processing and age modelling. For two master soil profiles we tested three data processing approaches, where the use of a Bayesian framework which combines bootstrapped Minimum Age Model likelihood functions with stratigraphic information (Cunningham and Wallinga 2012) provides us with the most robust results. The Bayesian analysis is performed with OxCal, and the resulting chronology indicates that soil redistribution in the kettle hole started approximately 1500 BCE, likely being trigged by the onset of deforestation in the region. Intensified agricultural use since the late 18th century CE seems to have caused intensive soil erosion which is reflected in very high colluviation rates for the last ∼220 years. Our OSL data furthermore suggests that the pattern of soil redistribution through space and time is highly complex and that numerical dating in combination with pedogenic knowledge is a prerequisite to identify phases of colluviation, and to prevent incorrect correlation of colluvial layers and thus misinterpretation of the landscape dynamics.