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Characterization of archaeological soils and sediments using VIS-spectroscopy

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The investigation of past environments includes the analysis of former soil properties, which were different from recent topsoil characteristics. Ancient topsoil material can be preserved over millennia, e.g. in prehistoric pits that were filled with material from the former surface. Thus, the colors of pit fillings are specific for the time the soil material has been relocated. Early Neolithic pit fillings in the loess area of NW-Germany, e.g., have a black to dark brown color, while Iron Age pit fillings have a lighter grey color. Up to now, the reasons for these color differences are unknown.
Soil colors reflect soil characteristics, and the correlations between color and soil components like charred organic matter or iron hydroxides can be measured using spectrophotometric data. The development of a quantitative spectroscopic method based on soil color spectra would enable the measurement of large amounts of samples, e.g. to investigate environmental or archaeological research questions on a regional scale.
The aim of our study is the assessment of soil profile information using VIS-spectroscopy, with a main focus on archaeological soil features, and to establish spectrophotometry as a rapid and reliable tool for the analysis of soils and sediments. Furthermore, we evaluate the color differences of pit fillings that are typical for a prehistoric period, and the differences in colors between two regions dominated by different soil types.
Soil color spectra were obtained in the 360 to 740nm range, in 10nm steps, using a field-spectrophotometer (CM-700d) and a lab spectrophotometer (CM-5). The spectrophotometric data was calibrated against soil sample sets that have been analysed on iron, carbonates, organic carbon, and pyrogenic carbon (BPCA). Samples were taken at archaeological excavations in the loess-covered regions of NW- and E-Germany. Mainly pit fillings were sampled that cover a chronological range from the Early Neolithic to the Roman period or Iron Age, respectively. Additionally, we investigated sets of palaeosoil records and cave sediments. We evaluated different color index values (e.g. Redness Rating), as well as the effects of soil moisture and texture. The spectral information was used to build models based on partial least squares regression.