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Can grain size distribution and soil color be used to determine loess proportions in soils?

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Grain size distribution (GSD) and soil color are routinely described parameters in soil investigation and classification, as they may provide important pedogenetic information. They are also commonly used to estimate loess addition to soils, as loess typically has silty texture and a hue of 10YR. The recognition of loess admixture in soils is highly relevant, especially in coarse-textured soils, because loess may greatly enhance several ecologically relevant soil properties such as water-holding capacity, nutrient availability, and pH. To evaluate the effects of loess admixture on these soil properties, however, we need to know the proportions of loess that have been mixed into soils. Can grain size and soil color be used to determine loess proportions in soils? Most pedologists would probably give a negative answer to this question, considering that the standard methods for grain size distribution may not be sufficiently sensitive, and the Munsell color is unquantifiable. Yet, substitutes of these methods, i.e. laser diffraction and spectrophotometry have existed for decades, although they are not widely used in soil science. We successfully tested, for the first time, the capabilities of these two methods in quantifying loess proportions in soils.

We described twenty soils developed on Pleistocene periglacial slope deposits (PPSD) in different topographic positions along a little valley carved into Lower Triassic sandstone (Buntsandstein) near Göttingen, central Germany. Loess has long been recognized as a component of the PPSD. Its relative abundance in a vertical profile is an important criterion to classify different layers of PPSD. In general, loess exhibits an increase from the upper layer (UL) to the intermediate layer (IL), while it is absent in the basal layer (BL). Grain size distribution of UL and IL samples showed a bimodal GSD pattern, with a silty modal size, corresponding to the loess component, and a sandy one, reflecting the local sandstone contribution. Further, the only slightly overlapping GSD curves of loess and sandstone allowed for the calculation of loess proportions in soils. Percentages of loess in loess-containing layers varied from less than 10% to more than 90%, showing maximum loess proportions in the ILs. Loess proportions calculated by laser diffraction data showed a high correlation (r2=0.88, n=79; A horizons excluded) with the b* value (yellowness) obtained by spectrophotometry. This close relationship suggests that 1) detailed GSD generates reliable results on loess proportions in the studied soils and 2) the b* value may be another sensitive proxy to calculate loess proportions in soils. It should be noted that the applicability of these two efficient and simple tools needs further validation, and that their successful use in this study was due to the strong contrast, both in texture and color, between red Triassic sandstone and yellow loess. The approach may be less useful for assessing loess proportions in PPSD with different petrology. Nevertheless, our research opens two new, easily applicable methods that may contribute to our understanding of the spatial variation of loess proportions in PPSD and the effects of loess admixture on soils and ecosystems.