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# From outcrop to spectrum

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Reconstructing source to sink relationships or the origin of sediments and sedimentary rocks is the main goal of sedimentary provenance analysis. Several processes alter the source signal during transport and deposition and the extraction of the initial provenance signal is usually realized by combination of multiple single grain methods determining mineralogy, chemical composition or radiometric ages. However, such methods are mostly applied to sand-sized sediments or sedimentary rocks, while finer grained material is usually analyzed by whole-rock geochemical means and seldom by single-grain methods. Considering the abundance of fine-grained sedimentary archives and that short lived climatic signals are frequently encoded in such archives (e.g. loess, varves, etc.), a strong need for single-grain, multi-method analyses of silt-sized sediments is obvious.

Therefore, we developed a highly automated approach to modal mineralogy of silt-sized sediments and sedimentary rocks based on image segmentation and object detection capabilities of machine learning methods, which allows for correlative analysis (e.g. optical microscopy, Raman spectroscopy, SEM, EPMA, LA-ICP-MS) and increased sample throughput.

To test if our approach is feasible for silt-sized sediments, we sampled three loess-paleosol-sequences (LPS) of similar age and from different loess domains. Based on heavy mineral compositional data and zircon U-Pb age distributions the LPSs can readily be differentiated, verifying the feasibility of our approach. Consequently, we hypothesize that this novel multi-method, high-throughput data acquisition within a highly automated workflow will allow for hitherto unprecedented spatial and temporal resolution as well as statistical significance of provenance information, potentially enabling new research pathways in sedimentary provenance analysis.