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X-ray fluorescence (XRF) scanning of discrete samples: Examples from the loess-paleosol sequence on the Island of Susak, Croatia

Jörn Profe (1), Lara Wacha (2), Manfred Frechen (3), Christian Rolf (3), Mihovil Brlek (2), Christian Ohlendorf (1), and Bernd Zolitschka (1)

(1) University of Bremen, Institute of Geography, GEOPOLAR, Bremen, Germany, (2) Croatian Geological Survey, Zagreb, Croatia, (3) Leibniz Institute for Applied Geophysics (LIAG), Hannover, Germany

Loess-paleosol sequences (LPS) are recognized as valuable terrestrial environmental archives. Although LPS provide discontinuous archives, high-resolution sampling and analyzing strategies are required for a sound reconstruction of past environmental conditions. Up to now, proxies such as grain size, rock magnetic properties and calcium-carbonate content are commonly investigated at the centimeter scale, whereas the elemental as well as the mineralogical compositions are analyzed at a much coarser resolution, e.g. with 10 cm intervals or once for every lithological unit. X-ray fluorescence (XRF) scanning of discrete powdered and homogenized samples is a new application of the XRF core-scanner technology providing a tool for fast and non-destructive qualitative measurement of the elemental composition along LPS. Tracking relative changes of the elemental distribution at the centimeter scale is considered as an important supplement to existing methods applied to LPS in order to gain a more detailed knowledge about weathering, dust provenance and sedimentation dynamics.

The island of Susak, situated in the north-eastern Adriatic Sea, represents an exceptional site with Pleistocene aeolian sediments of up to 90 m thickness covering at least the last glacial-interglacial cycle. The studied sub-profiles are part of loess cliffs located directly on the coast of Susak (Bok-Bay). Therefore, this record qualifies as a test candidate for benchmarking XRF scanning of discrete samples against magnetic susceptibility, organic carbon and lithological data. The following elements are studied as proxies for weathering (K, Ca, Sr, Rb), for dust provenance (Al, Si, Ti, Zr) and for organic matter (S, Br). In addition, Fe is directly linked to magnetic susceptibility. First results indicate a general agreement between lithologically identified paleosols and element weathering indices. Fe is predominantly positively correlated with magnetic susceptibility. The Ti/Zr-ratio points to a dust provenance change along the profile, albeit other parameters such as grain size variations possibly influencing this ratio need further investigations. S and Br show no correlation with total sulphur and total organic carbon percentages that have been determined with a CNS analyzer. Consequently, S and Br are not suited as proxies for organic matter at Susak. Instead, exceptional high Br and Cl contents are obtained for the top of a paleosol located very close to the Adriatic Sea. Therefore, we hypothesize that Br and Cl variations at Susak are strongly influenced by the proximity to marine water.

These initial results demonstrate the benefits of XRF scanning of discrete samples for the geochemical characterization of LPS opening up the possibility for more sophisticated LPS-based environmental reconstructions.