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Multi-proxy analytical characterization and palaeoclimatic interpretation of a loess-like permafrost palaeosol sequence in the Verkhoyansk Mountains, NE Siberia

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Loess-palaeosol sequences are valuable terrestrial archives for reconstructing past climate changes. We therefore studied a 15 m high loess-like permafrost palaeosol sequence (the Tumara Palaeosol Sequence, TPS) in the Verkhoyansk Mountains, Northeast Siberia. Based on the results of various analytical methods (numeric dating, grain-size distribution, elemental composition and characterisation of the organic matter) we aimed to develop a chronostratigraphy for the TPS.

Similar to typical loess-palaeosol sequences (e.g. in China, Europe etc.), pedogenetic clay formation, dominance of the fine silt fraction and mineral weathering are interpreted in terms of warmer and more favourable past climatic conditions (interglacials or interstadials). Soil organic matter (SOM), however, reveals an unfamiliar, inverse pattern: High organic carbon contents ($C_{org} > 1\%$) characterise the dark grey glacial palaeosols, whereas lower contents ($C_{org} \leq 0.5\%$) are found in the brown interglacial/-stadial palaeosols. We therefore suggest that during interglacial conditions the mineralisation of SOM in the topsoils was favoured. On the contrary, during glacial conditions water logging occurred in the thin active permafrost layers and thus

inhibited SOM mineralisation. This interpretation might be of relevance for the discussion of the global carbon budget. The D/L-ratios of aspartic acid and lysine proved to be useful proxies for both SOM aging and palaeotemperature with amino acid racemization being enhanced in interglacials/-stadials palaeosols. Further palaeoclimatically relevant proxies were developed and applied on the basis of the geochemical and grain size results: e.g. for the palaoewind-strength (U-ratio), the mineral weathering (Chemical Index of Alteration, Rb/K) and the changing mineral input signal (Ba, Ti/Zr, Ti/Al). Eventually, the synthesis of all climate proxies allowed us to establish a simple warm-cold stratigraphy for the TPS. In combination with numeric dating results (radiocarbon and luminescence) and in the context of other northern hemispheric records, this simple warm-cold stratigraphy as derived from the palaeoenvironment/-climate proxies suggests that the TPS represents the last $\sim$240,000 years.