Optically stimulated luminescence dating techniques and multi-proxy analysis to quantify the timing of the last two major climatic transitions, as recorded by loess-palaeosol sequences

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The practice of tuning different climate proxies prevents the observation of regional response times of terrestrial archives to global changes. Thus, it is imperative to develop correlation protocols based on absolute chronologies. Loess-palaeosol (L/S) deposits are continental archives of Quaternary paleoclimates and loess is generally considered an ideal material for the application of luminescence dating.

The agreement previously obtained for 10-20 ka ages using different techniques has given us confidence in using the state of the art measurement protocols for young deposits, as confirmed by comparison with independent age control. Therefore, we propose detailed investigations of loess samples collected in close proximity to the transition to the recent soil, with the purpose of obtaining a temporal quantification of the ending of the Late Tardiglacial and the beginning of the Holocene (i.e. L1/S0 boundary).

We illustrate the application of such an integrated approach on the Mosorin loess-palaeosol site, in the Vojvodina region, Serbia. Optically stimulated luminescence dating method was performed by applying the single aliquot regenerative (SAR) protocol (Murray and Wintle, 2003) to 4-11 μm and 63-90 μm quartz grains extracted from the topmost part of the profile. For the sake of a consistency check and for minimizing the final error on the obtained ages, the post-IR $IRSL_{290}$ protocol (Buylaert el al., 2012) was applied to 4-11 μm polymineral grains extracted from the same samples. In order to constrain precisely the transition the multi-proxy approach included rock magnetic analysis, grain-size distribution colour indices (proxy for variations of mineral concentrations) of loess-palaeosol were determined as well. The sampling strategy included the collection of doublet samples for luminescence dating at 15 cm resolution while collection of samples for proxy analyses was at 5 cm apart, in total 13 samples being collected for luminescence dating from the topmost 1 m of the section. The OSL age results obtained on the two quartz extracts agree and are internally consistent, whereas the post-IR $IRSL_{290}$ ages highly overestimate the quartz data (the equivalent doses generally being 100% higher than the fine quartz equivalent doses), as it has been previously

shown at young ages (Buylaert et al., 2011; Schatz et al., 2012). If the maximum rate of change in the magnetic susceptibility record (Dong et al., 2015) is considered, this proxy locates the Pleistocene/Holocene transition at 30 cm. For this depth the luminescence age, (average of coarse and fine quartz ages determined on two samples) is 10.9 ± 0.8 ka, whereas data from the other proxies indicate an earlier transition, at about 45 cm depth (13.4 ± 0.9 ka).

Consequently, obtaining a comprehensive absolute dating of the timing of the most recent glacial/interglacial transition recorded in loess deposits requires a higher resolution for both luminescence as well as proxy analysis that should be ideally applied to soils of greater thickness.

For dating the Termination 2 as recorded in loess-paleosol deposits, we encounter the problem associated with luminescence dating of older loess deposits. A series of recent investigations carried out on quartz of different grain sizes extracted from Romanian and Serbian and loess (Timar-Gabor and Wintle, 2013, Timar-Gabor et al., 2015) yielded intriguing results. The optical ages obtained on coarse quartz (63-90 µm) were reported to be systematically higher than those on fine quartz (4-11 µm) for ages >~40 ka. While the cause of this chronological discrepancy is being hitherto not fully explained, our ongoing studies on loess from China and Israel prove that this is a general effect, potentially affecting deposits worldwide, and raising significant doubts on previously obtained chronologies.

We present explore our on-going studies that aim at unraveling the cause of the observed discrepancy and at the development of an innovative dating protocol that will improve the accuracy of luminescence dating with the ultimate goal of providing a temporal quantification of L1/S1/L2 boundaries.

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