



Thermokarst processes in west-European loess series: new evidences for rapid climatic warming events during the Last Glacial

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For a long time, the imprint of millennial climatic cycles (D/O cycles) in the Last Glacial loess sequences has been related to the alternation of loess layers and arctic brown soil horizons, especially between about 60 and 30 ka BP (\pm MIS 3). Nevertheless, owing to erosion gaps and strong reductions in the sedimentation rate, there are always less individual soil horizons than D/O cycles during the same period, which makes correlations very difficult. The discovery in the Nussloch loess sequence (Germany) of a thermokarst structure including well preserved vegetal remains, mollusc shells, and relicts of former ice wedge casts, provides new evidences for a rapid climatic warming at the origin of a major erosion event during the Middle Pleniglacial (\pm MIS 3). This elongated thermokarst erosion gully incised the underlying deposits. The presence of deformed ice-wedge relicts along its very sharp and irregular lower boundary indicates a formation by thermal erosion linked to a rapid melting of the permafrost ice. The analysis of the biological data (vegetal remains and mollusc shells) allows to evidence interstadial conditions strongly contrasting with the over- and underlying loess environments. Radiocarbon dates from wood remains (average $32.26 \text{ 14C} / \pm 37.7 \text{ cal. BP}$) allow the correlation of the main thermokarst formation and infilling with GIS-8 from the GRIP ice core, following H4 event. Similar structures have been evidenced in other west-European loess sequences, most of them at the base of the Middle Pleniglacial formations. On the basis of a comparison with present day analogues from Alaska and Siberia permafrost areas, past “thermokarst events” are related to thermal erosion processes and proposed as markers for rapid warming periods in Last Glacial European loess sequences.