Pre-glacial rivers and first ice sheet advance: 10Be–26Al depth profile exposure age constraints from eastern Lithuania (NE Europe)

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Abstract

This study focuses on a pre-glacial fluvial succession preserved below the oldest tills in eastern Lithuania (NE Europe), aiming to reveal the timing of the first advance of the Fennoscandian Ice Sheet (FIS) into the Baltic region. In addition to depth-profile exposure dating using 10Be and 26Al, we applied facies analysis of outcrops, grain-size end-member modelling, palynology, borehole-based stratigraphic correlation, authigenic 10Be/9Be dating and luminescence dating. Depth-profile exposure modelling was applied to three outcrops, assuming complex scenarios involving several phases of fluvial accumulation and surface exposure, followed by burial beneath a till of unknown age, associated with an interval that included ice-sheet cover for a fraction of time, and a final burial stage beneath the Late Weichselian till, whose age was independently calibrated. The fraction of time affected by ice-sheet shielding was estimated by sensitivity tests at 15–23%. Pre-depositional denudation, exposure duration, and post-depositional denudation were treated as free parameters, resulting in relatively wide uncertainties. Nevertheless, the total exposure ages overlap, yielding a weighted mean age of 1.38 ± 0.33 Ma, indicating that pre-glacial fluvial deposition began at or shortly before the onset of the Middle Pleistocene Transition. The modelling suggests that the earliest glacial deposition reached the region only 30–167 kyr after fluvial sedimentation had commenced. Facies analysis and pollen assemblages indicate progressive cooling, possible paleofires, intensified erosion, and drainage-network reorganization, all likely related to the increasing proximity of the FIS before its final advance into the area. The research was supported by the grant No. APVV-23-0227.

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