



Tunnel-valley formation by catastrophic outbursts during the last deglaciation in SW Scandinavia

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Tunnel valleys are an integrated part of the subglacial environment and are widely distributed in northwest Europe. Most agree that they form by subglacial meltwater erosion but it is still debated whether it formed under steady state conditions or by catastrophic drainage events; mainly because of poor chronology of both tunnel valleys and infill sediments. In this study, a number of buried tunnel valleys were mapped in northern Denmark using transient electromagnetic method. The valleys are 2-13 km long, 0.5-2 km wide and up to 190 m deep. Four north-south and seven east-west oriented tunnel-valley systems were identified and their distribution can be linked to former ice margins. Boreholes were drilled in the centre and on the flanks of representative valleys in order to understand the depositional conditions of the tunnel-valley infill and to establish a chronological framework for their genesis. The recovered samples were analysed using a wide range of sedimentological and biostratigraphical proxies and the chronology was based on OSL and radiocarbon dating. Most of the tunnel valleys turned out to be incised into Eemian to Late Weichselian marine or lacustrine clays, and they were filled with silty and sandy sediments containing a mixed, redeposited Eemian and Weichselian fauna. The infilling of the tunnel valleys mainly occurred in a proglacial environment as the ice sheet retreated and tunnel valleys were exposed. Based on composite litho- and chronostratigraphical correlation of boreholes from within tunnel valleys and their flanks, the age of the valleys can be constrained to a narrow time-interval from c. 20-18 kyr BP. This gives only a few centuries to excavate and subsequently refill each tunnel-valley system. This also implies that much of the meltwater from the southwestern part of the Scandinavian Ice Sheet was drained in systems of tunnel valleys formed during catastrophic flood events.