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Flood and desiccation events reconstructed based on luminescence profiles and palaeobotanical proxies from the High Arctic lake Tenndammen, Svalbard

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We present a 700-year reconstruction of the environmental changes in the Colesdalen, Svalbard, inferred from a sediment core retrieved from lake Tenndammen (N 78°06.118; E 15°02.024). A comparison of modern and old maps revealed that the lake was artificially connected to its western tribute that now inputs additional water and sediment into the lake, but earlier lake Tenndammen was mainly fed by discharge and groundwater from the main valley. A multi-proxy approach was applied involving sedimentary ancient DNA (sedaDNA), pollen, spores, plant macrofossils, sedimentology and biogeochemistry. Establishing a chronology for this core was problematic as nine of the fourteen AMS dates were revered. However, core imaging as well as X-ray fluorescence (XRF) demonstrated clear stratification and undisturbed sediment layers. This is supported by the clear and coherent data obtained from the plant palaeo-proxies in terms of vegetation and environmental changes indicated by all proxies at the same core depths. From these observations, we inferred that lake Tenndammen experienced a number of floods which brought older sediments into the lake and produced a high proportion of the reversed dates. In order to test this hypothesis, portable optically stimulated luminescence (pOSL) and infrared stimulated luminescence (pIRSL) was employed. The pIRSL, pOSL and pIRSL/pOSL profiles suggested a series of 15 flooding and 8 drying events occurring at the depths associated with the reversed dates. However, relatively high amount of spheroidal carbonaceous particles (SCP, up to 1300 per gram of dried sediment mass) helped to improve the core chronology through a comparison with the calendar dates of the history of the coal mining and power production in Svalbard. SCP record allowed to find three tie points for the age-depth model at (1) the construction time of the power plant in 1911-1913 in Colesdalen, (2) the abrupt decrease in SCPs associated with the Second World War in 1941-1946, and (3) the highest output of the power plant in Colesdalen in the middle of the 1950s. When combined with the earlier non-reversed dates this provides an age-depth model with the basal age of the core at c. 730 cal. yr. BP and with the upper sediments deposited at c. 1950-1980s. Using this revised age-depth model, four chrono-stratigraphic units were described and, according to the data on luminescence profiling, the most intensive floods were associated with the second unit, which corresponded with the most intensive ice melting in the study area (c. 1670 - 1420 BP). The strongest drying events took place at the end of the second unit and in the first part of the third unit (c. 1655 BP). This was supported

by the plant proxies with an abundance of the aquatic and swamp bryophyta *Warnstorfia exannulata/Warnstorfia fluitans*, algae (i.e. *Closterium littorale, Cosmarium botrytis* and *Staurastrum punctulatum*) both in the non-pollen microfossils record and the sedaDNA. This study shows that a combination of biological proxies, sedimentology and pOSL can detect flood and desiccation events, and that lake Tenndammen was a highly sensitive fluvio-lacustrine systems during the late Holocene/Anthropocene.