ANHYDROSUGARS IN SEDIMENTS OF LAKE EL'GYGYTGYN - FIRE REGIME RECONSTRUCTIONS OF NE SIBERIA DURING THE LAST TWO INTERGLACIALS

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Fire is an important factor in global and regional biogeochemical cycles since the spread of biomass on Earth during the Silurian (Bowman et al., 2009). Regional fire regimes depend on interactions between climate and vegetation that influence biomass availability and flammability across temporal scales. Yet, it is strongly debated whether climate or vegetation are the main driver determining fire regimes (Harris et al., 2016). Hence, fire regime shifts under future climate change are difficult to predict, especially in the high-northern latitudes (Abbott et al., 2016). There, modern fire regimes vary strongly between tundra, summergreen (larch-dominated) and evergreen (pine and spruce-dominated) boreal forests. Yet, knowledge on past fire regimes in the high latitudes is scarce, especially on longer time scales that are beyond human influence.

Here, we investigate the long-term fire regime history of northeastern Siberia, using sediment core PG1351 from Lake El’gygytgyn that covers the last 270,000 years. We analyze two glacial-interglacial transitions of similar summer insolation, but different global ice volume and vegetation composition to characterize the fire regimes of a warmer than modern (MIS 5.5) and a cooler than modern interglacial (MIS 7.5).

For the first time, we provide long-term sedimentary records of the anhydrosugars levoglucosan, mannosan and galactosan (the monosaccharide anhydrides 1,6-anhydro-β-D-glucopyranose and its isomers 1,6-anhydro-β-D-mannopyranose and 1,6-anhydro-β-D-galactopyranose) in lake sediments of the high-northern latitudes. These thermal dehydration products of cellulose (LVG) and hemicellulose (MAN, GAL) form at burning temperatures <350 °C, thus representing low-temperature biomass burning of varying burning conditions (Kuo et al., 2008; Simoneit et al., 1999). We analyzed the molecular fire markers by ultra-high performance liquid chromatography-high resolution mass spectrometry using a method adapted from earlier HPLC-ESI/MS^2 methods (Hopmans et al., 2013; Schreuder et al., 2018). In addition and from the same samples, we analyzed sedimentary charcoal from pollen slides that reflects various combustion efficiencies from regional sources, whereas the presence of the spores of *Gelasinospora* (a fungi indicative for fires) depends on the regional availability of fire-disturbed soils.

We find high concentrations of all anhydrosugars in the El'gygytgyn sediments, affected by the lake's low sediment accumulation rates. Isomer ratios levoglucosan/mannosan and levoglucosan/(mannosan+galactosan) were very low compared to known ratios from biomass burning (Fabbri et al., 2009). Higher influx of all fire proxies during interglacials suggest greater fire activity compared to the preceding glacials. Yet, proxy ranges, proxy record variability and ratios between the fire proxies of the two interglacials were significantly different, on both millennial and centennial time scales. A comparison of fire proxies with pollen-based vegetation reconstructions from the same sediment samples suggests a strong dependence of fire regimes on regional vegetation composition (i.e. fuel type and availability). However, available climate reconstructions from the lake and the surrounding region also show a link between fire, temperature and permafrost thaw. Hence, understanding long-term internal climate-vegetation-permafrost feedbacks is crucial for high-northern fire regime predictions in the future.

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