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Refining Holocene environmental change and human impacts at Moossee, Switzerland, by exploring polycyclic aromatic hydrocarbons as innovative proxies for paleofire

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Charcoal has been the first choice when studying paleofire and related ecosystem disturbances over decades, because it can be easily obtained, for example, together with pollen. It is used to track changes in local versus regional fire activity (e.g., Vachula et al., 2018; Vachula, 2021, *Paleo3*). However, despite many progresses in charcoal analyses, specific information about paleofires such as fire intensity partly remains elusive, although such information is highly interesting particularly for archaeological sites where human impacts are expected.

Moossee is a small lake located near Bern (Switzerland) and is a key site to study past interactions between environment and human impacts because the presence of humans is documented at the site by lake pile dwellings since the Neolithic ~7 kyr ago. Moreover, the sedimentary record of this lake covers the last 19 kyr, has an excellent chronological control, and was already extensively studied by pollen and charcoal analyses at high temporal resolution.

We present first results of polycyclic aromatic hydrocarbons (PAHs) in the Moossee sediments covering the Mid and Late Holocene in 30-year resolution. PAHs are a relatively new, innovative proxy showing great potential to investigate fire characteristics and to corroborate charcoal data, since their composition varies depending on multiple factors, such as combustion temperature, intensity, and distance.

Our newly obtained PAH dataset generally agrees with the existing charcoal record from Moossee, although the PAH concentrations reveal a stronger variability in paleofires especially during pre-Roman times (i.e., prior to ~2500 cal. yr BP) where charcoal concentrations are low. However, we find high PAH concentrations during Late Iron Age (~2200 cal. yr BP) coinciding with higher charcoal concentrations related to the founding of a settlement at Bern. PAHs are dominated by low molecular weight compounds (molecular mass 152 to 202) until ~1300 cal. yr BP. The predominance of light PAHs together with low microscopic charcoal concentrations likely indicates local fire activity. This is also supported by new spatial calibrations suggesting that the distribution of light PAHs is spatially rather limited (Vachula et al., 2022, *Paleo3*). With the beginning of the

Middle Ages (~1300 cal. yr BP), high molecular weight PAHs (molecular mass 252 to 278) are dominant documenting higher burning temperatures and increasing regional fire intensity, which is in line with increased charcoal influx. This coincides with increasing human impact across the Swiss Plateau. A massive increase of PAHs with a simultaneous drop in charcoal concentrations since 150 cal. yr BP can be attributed to the industrialization and the combustion of fossil fuels.

In conclusion, our preliminary high-resolution PAH dataset from Moossee provides valuable new information that are only partly recorded by the already existing charcoal and pollen data. Thus, PAHs have great potential for studying paleofire history at Moossee, although more evaluation of the PAHs and their differences to charcoal is necessary. During the upcoming months, we will extend this PAH dataset with high-resolution compound-specific deuterium analyses on leaf waxes to further investigate links between hydroclimatic dynamics, environmental changes and the presence of paleofires at Moossee.