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Relating changes of organic matter composition of two German peats to climatic conditions during peat formation

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Peatlands have been recognized as an important factor within the global C-cycle, since they store about one-third of the global terrestrial C-pool. Furthermore, peat deposits have the potential to record detailed paleoclimatic and – vegetational changes. They are formed in peculiar paleoecosystems where the slow biodegradation of plant residues depends on a series of pedo-climatic and hydromorphic factors leading to a progressive accumulation of organic matter stabilized in different evolutionary stages. Thus, its chemical composition should be applicable as a fingerprint of former prevailing environmental conditions and vegetation configurations. The aim of the present work was to identify this fingerprint in the cores of two German fens, one derived from the Havelland close to Berlin (Großer Bolchow) and the other derived from the alpine region of Bavaria (Kendlmühlfilzen) by investigating the organic matter transformation as a function of peat depths.

The C/N ratios and 13C values revealed several distinctive trends in the two profiles related to prevailing peat forming conditions. Compared to the other layers, at depths of 14-85 cm and 132-324 cm in the Kendlmühlfilzen fen, high C/N ratios and less depleted 13C values, indicated that the accumulation of these two layers occurred during a humid and cold period. In the case of the “Großer Bolchow”, algal contributions were clearly detected using 13C values. Solid-state 13C NMR spectroscopy demonstrated loss of celluloses and accumulation of lipids and lignin derivatives during peatification, confirming that under the mostly O2-depleted conditions in peats, decomposition was selective. The results obtained by pyrolysis-GC/MS were in good agreement with the NMR data showing that processes ascribed to gradual biotransformation of the lignin occurred in both peats. However, the “Großer Bolchow” peat revealed a more advanced decomposition stage then the “Kendlmühlfilzen” peat, which is in agreement with less favorable climatic conditions during the formation of the alpine fen. The distribution of n-alkanes, n-fatty acids and n-alkan-2-ones demonstrated changes related to vegetational shifts throughout the peat profiles. The source materials included remains from mosses, higher terrestrial plants as well as microbial sources. In the peat of the “Großer Bolchow”, contributions from phytoplankton were also identified. Among the alkyl series, the n-alkanes evidenced the highest reliability as biomarkers in the peat deposits. Although combination of the results of the three alkyl series were complementary, in some cases, this approach lead to ambiguities, possibly because of selective preservation of certain lipids during peatification. Thus, to verify the analytical results, they were supplemented with field assessment data. Subjecting the two peats to CuO-oxidation revealed mainly contributions of mosses and grasses. The analysis of the degradation stage of the lignin derivatives supported the decomposition pattern already revealed by the 13C data and the NMR analysis.

In summary, our study confirmed that in peat, changes in biomarker abundance and distribution are in accordance with chemical alterations of the organic matter composition. However, both biomarker abundance and the degradation state of the organic material did not indicate a constant increase of the humification with peat depths but showed clear fluctuations along the core. This is in line with the constantly changing climatic conditions during peat formation that are either favoring or hindering organic matter accumulation.