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Characterization of the degree of decomposition and CO_2 and CH_4 production rates in three pristine ombrotrophic bogs in Southern Patagonia

Tanja Broder (1), Klaus-Holger Knorr (1), Harald Biester (2), and Christian Blodau (3)

(1) Limnological Research Station & Dept. of Hydrology, University of Bayreuth, Universitätsstr. 30, 95440 Bayreuth, Germany, tanjabroder@gmx.de, (2) Geochemistry, Dept. of Environmental Geology, Technical University of Braunschweig, Langer Kamp 19c, 38106 Braunschweig, Germany, (3) Canada Research Chair in Environmental Geology, Axelrod Building, University of Guelph, Guelph, Canada

Peatlands of Southern Patagonia receive increasing attention in research, although they represent only a small fraction of the global peatland area. A very low population density and negligible nutrient deposition have conserved large and pristine bogs and mires, representing archives for paleoclimate and past environmental conditions.

Controls of carbon storage and decomposition processes have been intensively studied in northern bogs and thus most factors constraining decomposition have been previously described. For Southern Patagonian peatlands yet only few studies exist and a verification of these controls and patterns in these southern ecosystems has so far not been achieved. To obtain a general characterization, we investigated the degree of decomposition and CO_2 and CH_4 production rates at three ombrotrophic bogs in vicinity of Punta Arenas, Chile, and compared the results to a well studied Canadian bog. The three sites differed in terms of precipitation, seaspray input, and vegetation. Furthermore, at all three sites distinct ash layer occurred that can be expected to affect peat decomposition. Peat solid phase was characterized by C and N contents, FT-IR absorption spectra, and trace element contents; pore water was analyzed for dissolved gases and major ion concentrations.

The highest degree of decomposition was found at the driest site with a humification index of up to 1.4 as calculated from FT-IR measurements; the other sites were mostly below 1.0. This is very low compared to Mer Bleue, Canada (up to 1.73). C/N ratios were mostly in a range from 40 to 100, with a more or less decreasing trend with depth. There was no consistent pattern of the degree of decomposition at all three sites and the degree was rather varying with depth. The identified ash layers seemed to have an enhancing effect on decomposition, as we observed a higher degree of decomposition above each distinct ash layer. Furthermore, a strong negative correlation between C/N ratio and humification index could be calculated for all three sites (0.01 level of significance; n=77).

Pore water concentrations of CO_2 increased with depth and highest concentrations of the different sites ranged from 4000 to 6000 μmol L^{-1}. A similar pattern could be seen for CH_4 concentrations with highest values of 250 to 3000 μmol L^{-1}. Steepest concentration gradients occurred in the upper 75 cm. Highest CO_2 and CH_4 concentrations occurred at the site with lowest degree of decomposition and intermediate precipitation, while the driest and most decomposed site showed lowest methane concentrations. An obvious different pattern of methane and carbon dioxide production could clearly be seen at CO_2:CH_4 ratio, which is much higher at the highly decomposed site ($\sim$ 5-10) compared to the other two investigated bogs ($\sim$2.5). This may also be an effect of higher seaspray-input, which might have caused the higher sulfate concentrations observed at the driest site. Compared to similar measurements on the Canadian Mer Bleue bog, methane concentrations exhibit a much higher concentration range, while carbon dioxide concentrations were comparably low (5000-7000 μmol L^{-1} in Mer Bleue, CDN).

Overall, there was no gradual increase in the degree of decomposition in the catotelm region, but the profiles seemed to reflect a record of the paleo-environmental conditions. As the ash layers obviously enhanced decomposition, interpretation needs to be done with care, though. All investigated Patagonian bogs were less decomposed compared to a northern bog and highest decomposition was found at the driest site, which is consistent with previous studies. Differences in CO_2 and CH_4 production may be explained by inhibition of methanogenesis by enhanced sulfate concentrations due to seaspray input.