Stable carbon isotopes as indicators for environmental change in palsa peats

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Palsa peats are unique northern ecosystems formed under an arctic climate and characterized by a high biodiversity and sensitive ecology. The stability of the palsas are seriously threatened by climate warming which will change the permafrost dynamic and induce a degradation of the mires. We used stable carbon isotope depth profiles in two palsa mires of Northern Sweden to track environmental change during the formation of the mires. Soils dominated by aerobic degradation can be expected to have a clear increase of carbon isotopes (δ13C) with depth, due to preferential release of 12C during aerobic mineralization. In soils with suppressed degradation due to anoxic conditions, stable carbon isotope depth profiles are either more or less uniform indicating no or very low degradation or depth profiles turn to lighter values due to an enrichment of recalcitrant organic substances during anaerobic mineralisation which are depleted in 13C. The isotope depth profile of the peat in the water saturated depressions (hollows) at the yet undisturbed mire Storflaket indicated very low to no degradation but increased rates of anaerobic degradation at the Stordalen site. The latter might be induced by degradation of the permafrost cores in the uplifted areas (hummocks) and subsequent breaking and submerging of the hummock peat into the hollows due to climate warming. Carbon isotope depth profiles of hummocks indicated a turn from aerobic mineralisation to anaerobic degradation at a peat depth between 4 and 25 cm. The age of these turning points was 14C dated between 150 and 670 yr and could thus not be caused by anthropogenically induced climate change. We found the uplifting of the hummocks due to permafrost heave the most likely explanation for our findings. We thus concluded that differences in carbon isotope profiles of the hollows might point to the disturbance of the mires due to climate warming or due to differences in hydrology. The characteristic profiles of the hummocks are indicators for micro-geomorphic change during permafrost up heaving.

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