Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.23946

Spatial and seasonal relationship between ^{17}O-excess of grass phytoliths and relative humidity in the North American Great Plains

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The ^{17}O-excess of grass phytoliths has high potential to be a good proxy for past continental Relative Humidity (RH), an important climate parameter that is difficult to accurately estimate. A strong correlation between ^{17}O-excess of grass leaf phytoliths and RH has been previously demonstrated in growth chamber experiments [1]. Similar correlations have been shown between the ^{17}O-excess of soil phytoliths and RH of the rainy season in West African grassland and forest ecosystems. In this study, we focus on the potential of ^{17}O-excess of grass phytoliths as a proxy of RH across the North American Great Plains. Stems and leaves of *Calamovilfa longifolia* grass were sampled in seventeen grasslands across North America. A strong correlation between the ^{17}O-excess of grass leaf phytoliths and late-growing season daytime RH (RH range: 29-72%) across North America has been found and can be expressed as: $^{17}O\text{-excess}_{\text{leaf phytoliths}} = 4.14(\pm0.47) \times RH - 497(\pm26)$ ($R^2 = 0.85$, p-value<0.0001) (Fig. 1). This relationship is close to the one previously obtained in the growth chambers. The ^{17}O-excess of stem phytoliths was found constant (–161±19 per meg) and high compared to the ^{17}O-excess of leaf phytoliths. The contribution of stem phytoliths in soil and sediments phytoliths may thus bias the ^{17}O-excess of soil phytoliths toward high values and lead to RH overestimation when using the above equation. Analyses of soil or sediment phytolith assemblages are required to estimate this bias.

A seasonal sampling at Strathroy, Ontario also shows that the ^{17}O-excess of phytoliths from grass leaf and bulk (stem and leaf) phytoliths collected at the end of the growing season records the late-growing season RH (Fig. 1). The ^{17}O-excess of stem waters estimated from stem phytoliths are close to the ^{17}O-excess of soil and rain waters (Fig. 2), indicating that soil water taken up by plants is barely influenced by evaporation in this humid continental climate.

Both the spatial and seasonal relationships between ^{17}O-excess of phytoliths and RH in this study demonstrated that the ^{17}O-excess of grass phytoliths is a promising proxy for RH across the North American grasslands.

[1] Alexandre, A. et al. Biogeosciences, 15(10), (2018)

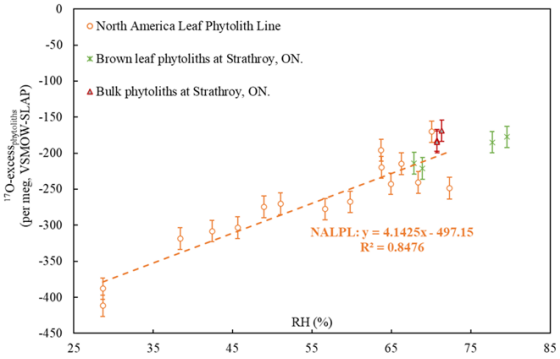

Figure 1. The relationship between late-growing season RH and $^{17}O\text{-excess}_{\text{phytoliths}}$ of (1) leaves of *Calamovilfa longifolia* across North America; (2) brown leaves of *Bromus inermis* at Strathroy, ON, and (3) measured bulk *Bromus inermis* at Strathroy, ON at the end of the growing season.

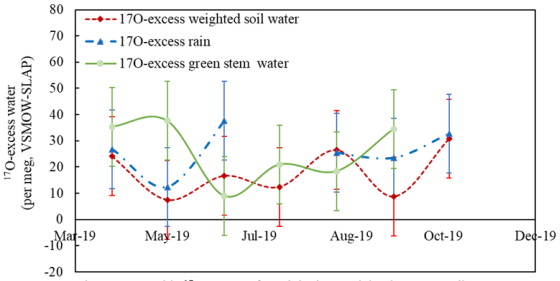

Figure 2. Monthly ^{17}O-excess of precipitation, weighted average soil water to a depth of one meter, and estimated green stem water at Strathroy, ON.