

Mycorrhizal weathering and the long-term carbon cycle

L.L. TAYLOR¹, S.A. BANWART² AND D.J. BEERLING¹

¹Animal and Plant Sciences, University of Sheffield, UK

(*correspondence: L.L.Taylor@sheffield.ac.uk)

²Cell-Mineral Research Centre, Kroto Institute, University of Sheffield, UK

Plant evolution is postulated to have enhanced silicate weathering fluxes via increased rooting depths in the Devonian, and the spread of angiosperms at the expense of gymnosperms from the Cretaceous onwards (*eg.*, [1]). An alternative more encompassing hypothesis is that the coevolution and spread of ectomycorrhizal fungi (EMF) along with trees of the Pinaceae and several dominant angiosperm families were key biological events contributing to the late Phanerozoic CO₂ drawdown [2]. EMF differ from the ancestral arbuscular-mycorrhizal fungi in that they can aggressively weather minerals by exuding organic acids. Here, we employ numerical modelling techniques to investigate the effects of the rise of EMF on weathering and long-term CO₂ trends. Our model includes factors such as rooting depth, fine root and hyphal length densities, net primary productivity, acidification during nutrient uptake and ligand- and proton-promoted weathering resulting from organic acid exudation by EMF. Starting with the GEOCARBSULF model [3] and a conceptual model of the effects of biological processes driving the proton cycle in soil solution chemistry [4], we develop a process-based model that permits sensitivity analyses of the above effects on atmospheric CO₂ via the long-term geochemical carbon cycle.

[1] Berner (2004) *The Phanerozoic carbon cycle. CO₂ & O₂*. Oxford University Press, Oxford. [2] Taylor *et al.* (2009) *Geobiology* **7**, 171–191. [3] Berner (2006) *GCA* **70**, 5653–5664. [4] Banwart *et al.* (2009) *Global Biogeochem. Cycles* **23**, GB4013.

Evaluating isotopic and geochemical spatial variability in lake sediments

Z.P. TAYLOR^{1*}, D.B. FINKELSTEIN² AND S.P. HORN¹

¹Department of Geography, University of Tennessee,

Knoxville, Tennessee 37966-9025

(*correspondence: ztaylor1@utk.edu, shorn@utk.edu)

²Department of Earth and Planetary Sciences, University of Tennessee, Knoxville, Tennessee 37996-1410
(dfinkels@utk.edu)

Most lake-sediment based palaeoenvironmental studies rely on a single core and do not consider the potential complication of intra-basin spatial variability. To detect and quantify spatial variation in geochemical and isotopic signals in lake sediments, we recovered a network of cores from Laguna Zoncho, a small lake in southwestern Costa Rica with a known history of prehistoric maize agriculture.

Proxy data from all the lake cores show the same general pattern of agricultural activity followed by forest recovery. Using the period after reforestation as a baseline, the impacts of prehistoric agriculture can be assessed. Increased erosion lowered organic content from 16% to 5%. Molar CN ratios decrease from 16 to 13, indicating increased terrestrial inputs. $\delta^{13}\text{C}$ values increased from -27‰ to -23‰ VPDB, consistent with an increase in C4 vegetation as C3 forest was replaced by C4 vegetation in agricultural fields. These changes also lead to a slight increase in lake productivity which is suggested by 2‰ more positive $\delta^{15}\text{N}$ values.

Comparisons between cores indicate that agricultural activity did not end simultaneously throughout the watershed. Three cores taken near the edge of the lake indicate an abrupt cessation of agriculture around 1000 BP, but one contains the signal until approximately 700 BP. In the centre core, the agricultural signal gradually fades from ~700–1000 BP, suggesting that this core contains a mixture of material from the entire lake. The additional information provided by our multiple core approach reveals that most agricultural activity ended abruptly ~300 years earlier than previously thought, implicating factors other than the Spanish Conquest in the population and agricultural decline at Laguna Zoncho.