Geophysical Research Abstracts
Vol. 18, EGU2016-8515, 2016
EGU General Assembly 2016

Tracing terrestrial carbon: a novel application of Δ14C in a humic lake

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Lakes play an important yet underrated role in global carbon cycles. Terrestrial carbon (C) is buried and/or remineralised in significant quantities, and lake function may also be affected by catchment inputs with potential feedbacks for regional and global C cycling. Changing deposition chemistry, land use and climate induced impacts on hydrology will affect soil biogeochemistry, terrestrial C export, and hence lake ecology.
Autochthonous production in lakes is based on dissolved inorganic C (DIC). DIC in alkaline lakes is partially derived from weathering of carbonaceous bedrock, a proportion of which is 14C-free. The low 14C activity yields an artificial age offset leading samples to appear hundreds to thousands of years older than their actual age. Dissolved organic carbon (DOC) and particulate organic carbon (POC) can contain terrestrial inputs. The terrestrial inputs can be labile or detrital and their age depends to a first order on their depth in catchment soil/peat stocks.

We present a pilot study that uses the radiocarbon (Δ14C) method to determine the source of carbon buried in the surface sediment of Lower Lough Erne, a humic, alkaline lake in northwest Ireland. Δ14C, δ13C and δ15N values were measured from phytoplankton and other biota, dissolved inorganic, dissolved organic and particulate organic carbon. A novel radiocarbon method, Stepped Combustion1 was used to estimate the degree of the burial of terrestrial carbon in surface sediment, collected in 2011.

The Δ14C values of the low temperature fractions were comparable to algal Δ14C, while the high temperature fractions were 14C-depleted (older than bulk sediment). The Δ14C end-member model indicated that $\sim$64% of carbon in surface sediment was derived from detrital terrestrial carbon. The same proportion of detrital/labile carbon was found in surface sediment of Upper Lough Erne in 2014, despite the differences in lake type and collection date. The use of Δ14C in conjunction with stepped combustion allows the quantification of the pathways of terrestrial carbon in the system, which has implications for regional and global carbon burial.

1McGeehin, J., Burr, G.S., Jull, A.J.T., Reines, D., Gosse, J., Davis, P.T., Muhs, D., and Southon, J.R., 2001, Stepped-combustion C-14 dating of sediment: A comparison with established techniques: Radiocarbon, v. 43, p. 255-261.