Isotope constraints on the biogeochemical cycling of calcium (Ca) in a base-poor forest ecosystem

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We studied the biogeochemical cycling of Ca in an old-growth forest at Wachusett Mountain, which feeds the Nashua River Watershed located in central Massachusetts, the northeastern USA. The forest grows on naturally base-poor soils (i.e. Ca and Mg depleted) developed on the granodioritic bedrock of Precambrian age. Trees are thought to obtain dissolved Ca mainly from an easily accessible soil-water reservoir termed the 'exchangeable cation pool'. The status of Ca reserves in this soil pool is sensitive to anthropogenic soil acidification and excessive timber harvesting. Our study shows that in the base-poor forest at Wachusett Mountain the 'exchangeable Ca pool' of mineral soils has a unique isotope signature that is significantly enriched in radiogenic ^{40}Ca due to the dissolution of K-rich silicate minerals such as biotite. In contrast, samples of local vegetation (i.e. woody tissues of red oak) show no detectable excess of the radiogenic ^{40}Ca, thus challenging a prevalent belief that the 'exchangeable cation pool' of mineral soils plays an important role as the source of Ca in forest nutrition. This study shows that base-poor forests are able to bypass the 'exchangeable Ca pool' in mineral soils, and still meet their nutritional needs, thus being largely independent of the rock-derived nutrient sources. Consequently, the growth of base-poor forests must rely primarily on alternative Ca sources, which do not show the radiogenic ^{40}Ca excess. Such sources of Ca may include (i) atmospheric deposition [1, 2], (ii) recycling of the forest-floor organic matter, and/or (iii) the fungal-mediated dissolution of apatite [3]. Finally, we will also discuss temporal variations in the Ca isotope composition of a tree-ring record from a 260-year old red oak collected at our study site.

[1] Holmden & Bélanger (2010) *Geochimica et Cosmochimica Acta*. **74**, pp. 995-1015; [2] Kennedy *et al*. (2002) *Proceedings of the National Academy of Sciences* **99**, pp. 9639-9644; [3] Blum *et al*. (2002) *Nature* **417**, pp. 729-731.

Rapid climate change during marine isotope stage 5-4 glacial inception in the subpolar North Atlantic

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Previous work from North Atlantic core NEAP 18K highlighted the occurrence of a number of previously unrecognised ice rafting events occurring not only during periods of greatest ice volume, but also during periods of ice sheet growth and decay. Ice core records highlight two events (Dansgaard-Oeschger (DO) events 19 and 20) during the transition between MIS 5 and 4 as the largest events in the last 100 ka, with temperature shifts in excess of 10°C over a matter of decades.

In the present work, the new record from NEAP 17K is presented. A neighbouring core to NEAP 18K, this core has a higher accumulation rate through the MIS 5/4 period, and, like NEAP 18K, is in a key region for monitoring the movements of the polar front and changes in the surface to deep ocean connectivity and potential for NADW production over glacial-interglacial time scales

Two rapid shifts in faunal assemblage are clearly evident during the transition. SST estimates indicate temperature shifts in the order of 8°C. These oscillations correlate with DO events 19 and 20, and are preceded by small ice rafting events, C19 and C20, coincident with a freshening of the surface waters. Benthic stable isotope data provide stratigraphic control and allow us to examine the relative strength of North Atlantic Deep Water production. Mg/Ca records separate the response of the surface and subsurface water masses and provide an intriguing alternative temperature record.

These records support the ice core proxies in suggesting that this interval was a period of extreme and rapid climatic change in the North Atlantic. The linkage between the surface and deep ocean, and the parallels in the Greenland ice cores, would indicate that these events were not local to Greenland alone but were felt across the North Atlantic region and are associated with a significant reorganisation of North Atlantic circulation.