Geophysical Research Abstracts,
Vol. 11, EGU2009-5389, 2009
EGU General Assembly 2009

Testing the apatite depletion hypothesis for early Holocene ecosystem acidification using the lake sediment record at Kråkenes, Norway.

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Lakes created by retreating ice at the end of the last glaciation underwent rapid acidification during the first few thousand years of their existence, a phenomenon that has been attributed in part to progressive leaching of soil bases since it was discovered more than 80 years ago. Though a role for leaching is still acknowledged, the most recent studies see this as subordinate to the effects of biological and climatic changes initiated by deglaciation, chiefly primary vegetation succession and species immigration. However, we propose a simpler alternative explanation, based on the geochemical modelling of runoff acidity. This shows that the extent and timing of early Holocene lake acidification in eight published palaeoecological records can be explained by leaching of the calcium phosphate mineral apatite from the granitic till soils of their catchments, at a rate controlled by simple dissolution kinetic factors.

If confirmed, this hypothesis has important implications for our understanding of long-term lake ecosystem development. Not only does it mean that the mechanism is inherently irreversible, in contrast to the alternative ecological and climatic mechanisms which are not. Also, it reinforces the view that long-term ecosystem modelling cannot safely neglect nutrient limitation, as is currently the practice in widely used global dynamic vegetation models. Here we present a NERC-funded programme of research that uses the sediment mineral record of Kråkenes (western Norway), the best studied early Holocene lake sediment sequence in the world, to provide a simple, critical and unambiguous test of this hypothesis.