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The significance of phosphorus 'hot spots' and micron-sized grains in Quaternary forest soils

GBOTEMI A. ADEDIRAN[1], MELANIE KIELMAN-SCHMITT[2], ELLEN KOOIJMAN[2] AND JON PETTER GUSTAFSSON[1]

[1]Swedish University of Agricultural Sciences

[2]Swedish Museum of Natural History

Presenting Author: GboAde@ceh.ac.uk

Recent advances in soil phosphorus (P) studies have revealed unique P 'hot spots' and discrete micron-sized grains at soil microsites[1, 2], but the significance of these so-called 'hot spots' and grains in P cycling and long-term supply is yet to be determined.

We revealed soil architecture at a micro-scale in two postglacial forest soils in Sweden by micro-focused synchrotron X-ray fluorescence microscopy and laser ablation (LA)-ICPMS imaging. This allowed us to quantitatively establish both axial and lateral abundance, distribution, and co-localization of P with elements known to influence its speciation (e.g., Si, Al, Mn, Ca, and Fe).

The results show topsoil P to be co-localized predominantly with Si, Al and Fe. However, in the subsoils, P was co-localized mainly with Ca in hot spots within Si and Al-bearing minerals and in micron-sized grains. P concentrations in these hot spots and grains were from 7 to 600 times greater than the average soil P concentrations, with the highest values (2,542 – 8,716 mmol P kg^{-1}) occurring at the 90 – 100 cm depths in the two soils.

When combined with previous results of P speciation analysis by synchrotron P *K*-edge XANES in the same soils[1], our work firmly establishes geogenic apatite to have been dissolved in the top-soil and its P transformed to P adsorbed by allophane and ferrihydrite, and as organic P. Most importantly, our work shows sub-soil hot spots of apatite inclusions and micron-sized grains to be a long-term source of P that trees could potentially utilize.

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